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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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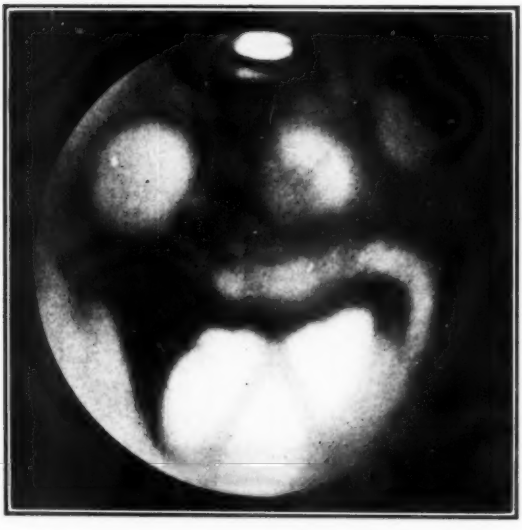
PLATE I.



THE PLANET MARS IN 1909.

Drawing by Scriven Bolton, Leeds, England. October 24, 10 p.m., G.M.T., (after Opposition). Instrument used, 18½-inch Calver Reflactor, Power 322. (See page 74).

THE JOURNAL

OF THE

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VOL. VI. JANUARY FEBRUARY, 1912. No. 1

THEORIES OF WORLD MAKING

BY A. T. DELURY

(RETIRING PRESIDENT'S ADDRESS, ANNUAL MEETING, JANUARY 16, 1912).

AT this meeting, the last of the year, the tradition of the Society calls for a paper from the retiring President. So little time have I had of late for keeping in touch with astronomical progress, that it has been a difficult matter for me to decide upon a suitable subject for your attention this evening. In the end I found myself very near the subject which I had the honor of treating before you on a like occasion last year,—"The Evolution of Worlds." The more outstanding evidences of a progressive development in the systems making up the universe were then stated and examined. These evidences of an all-embracing cosmic evolution are generally regarded to be conclusive. So vast, however, are the time and space implied in the process, so great is the quantity of matter involved, and so different are the conditions under which this matter has had to exist, from those within the range of our experience, that the problems of the details of the transformations, of the veritable march of the development, is far from a final solution. The problem none the less attracts, and round it have gathered a number of hypotheses, each, with its set of auxiliary hypotheses, hoping to hold

the key to the ultimate mystery. These hypotheses are tested in the first instance by their relative adequacy to explain, or rather to account for, the facts presented by our local solar system, the only system of which we can say that we have a body of intimate facts. A further relative test is found in the degree in which the conditions introduced are seemingly reflected in the remote systems. On the subject of cosmic theories there appeared within the year now closing an important work by Poincaré, *Les Hypothèses Cosmogoniques*. In this work — a course of lectures to advanced students of the Faculty of Sciences at Paris — the distinguished scientist examines in detail the arguments for, and the objections to, the more outstanding hypotheses that have been formulated. The great value of the book will, I think, be found in the fact that in a matter where scientific judgment and acumen is quite as large a part as positive demonstration, we have presented to us the opinions, the doubts, and the hesitations of one competent in almost unequalled degree to approach the problem. The reading of this work has led me to consider with you this evening certain of the cosmic hypotheses that have most claimed attention.

As the theories will be examined principally in relation to the solar system it may be well to bring together the more essential facts pertaining to that system :

(i) The Solar System consists of a central body, the Sun, and a number of planets, Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, Neptune.

(ii) The planets revolve about the sun in orbits that are ellipses, the sun being at a focus of each elliptical orbit. The ellipses approximate very closely to circles, *i. e.*, their eccentricities are small.

(iii) The planes of the orbits lie close to one another being inclined at angles not greater than $7^{\circ}\ 15'$ to what will be called the plane of the solar equator. As a phenomenon, the sun and the planets are seen from the earth ever within a narrow belt of the heavens.

(iv) The sun rotates on an axis which determines the solar equatorial plane. The planets also rotate and several of them have one or more satellites or moons which revolve about the parent planets much as the planets themselves revolve about the sun. One planet is surrounded by a ring, or rather a set of rings, which revolves about the planet.

(v) The planes of the orbits of these moons are for the most part but slightly inclined to the equatorial planes of the parent planets and to the solar equatorial plane.

(vi) The sense of all these movements — with certain exceptions to be noted later — whether of rotations of the sun and the planets, or of revolutions of planets or satellites, is the same, that of west to east in the heavens, as we say.

To these, with a view to definiteness in the image called up, though the facts cited are not without moment to any theory, let us add

(vii) The mean distances of the planets from the sun range from 36,000,000 miles, that of Mercury, to 2,792,000,000 miles, that of Neptune. The volume of the sun is large compared with any or all of the planets; if we call the volume of the earth 1, that of Jupiter is 1,309, the aggregate volume of all the planets is 2,221, while the volume of the sun is 1,310,000. If we call the mass of the earth 1, that of Jupiter is 318, the aggregate mass of the planets is 446, while the mass of the sun is 332,000.

To account for the unity or solidarity suggested by the small eccentricities of orbits, the approach to coincidence of the orbital planes, the uniformity in the sense of motion, many early speculative views were entertained, but we shall pass them by to consider the hypothesis stated first by Laplace in 1796, usually referred to as the Nebular Hypothesis.

It would be interesting and illuminating to quote from Laplace the considerations that led him to entertain the theory that bears his name, as well as his statement of the formal hypothesis, for, very generally, the outlines of his views have failed to present or insist upon certain essential

features. Time, however, will not permit this and I shall have to ask you to be content with a condensed account which will, at least, emphasize the features to which I have referred.

In seeking the veritable cause or source of the phenomena cited, Laplace points out that it must have embraced all the planets, and, distances considered, it must have been a fluid of vast extent. To have imposed an almost circular movement in the same sense about the sun, this fluid must have surrounded the sun, as an atmosphere that must have extended beyond all the planets. Through loss of heat the atmosphere would progressively retire under the action of gravity, and if we suppose it endowed with a motion of rotation, necessarily slow, but as of one mass with the sun, we have a brief statement of the undeveloped hypothesis. The march of the process would be condensation through loss of heat with the necessary increase in rate of rotation, and the reaching of a stage when at the equator the velocity of the particles of matter would be such that the so-called centrifugal force would balance the force of gravity, when zones of vapor would be abandoned. While these zones might be expected to condense into rings, the uniformity which this would demand both in the material of the ring and in the process of cooling would have been rare, the only instance being the rings of Saturn. The disruption of rings would lead to the formation, under attraction, of spheroidal masses with a movement of rotation in the sense of their revolution since the inner molecules had a slower velocity than the outer ones. If one of these masses were sufficiently large, it would attract the others to it to form one such spheroidal mass with the motion of rotation as described. In the smaller planets — the asteroids with orbits intermediate to those of Mars and Jupiter — we have, perhaps, a disrupted ring not aggregated into a single planet. The formation of satellites would be analogous. Inequalities in temperature and density — for there could scarcely have been uniformity in these qualities — would produce the deviations from regularity that appear in the slight eccentricities of orbits and in the slight inclinations of orbital planes. Laplace thought that our system at one

time might have presented some such appearance as do the nebulæ which under the telescopes of the time suggested, in general, a strong central condensation. Thus to his speculations came to be associated the name Nebular Hypothesis.

This bold and genial theory, commended by the authority of Laplace as well as by what we may call its reasonableness, held almost undisputed sway over the minds of men throughout the greater part of a century. But, very early, difficulties appeared. In the first place, it was not clear that certain phases of development could be justified on dynamical grounds. Again, in time, the telescope revealed striking though not numerous variations from that uniformity in the movements of the planets and satellites which had suggested the hypothesis. Last of all, the advances in the sciences that touch the problem of evolution called for modifications in the presentation of the theory so fundamental that to many it seemed that the hypothesis was ceasing to be itself. The more striking of these difficulties will now be considered.

About the middle of the century, E. Roche, Professor at the University of Montpellier, set himself the problem of giving to the theory of Laplace the precision that comes from a specific mathematical or dynamical treatment and of following it out to its logical consequences. The papers of Roche were published in the proceedings of the Academy of Montpellier; they were given a wider publicity in the great work of Tisserand and now find a clear exposition in the already cited work of Poincaré. It is shown that under the supposition of a strong central condensation and of a movement of rotation by which each particle of the atmosphere is carried, not independently, but as part of a rotating whole made up of sun and atmosphere, the results claimed by Laplace are, in the main, either normal or possible. Gaseous matter would not escape in a continuous stream at the equator but would be left behind in rings of vapor at epochs and and in this regard the supposition of strong central condensation and of uniform motion of rotation as of one body is necessary. The rings abandoned would normally in time become unstable,

and under rupture could aggregate into planets, though the time implied in this would be very great. When it came to the abandonment of zones of vapors by the condensing planet, and the advance to the sub-planetary or satellite condition, a new element or influence in the development of a system from the planetary centre appears in the attraction of the sun. The action of the sun through tidal distortion and friction would tend to equalize the periods of rotation and of revolution of the planet; later, the planet condensing, the tidal effects would be less and the rate of rotation of the planet would increase. In like manner the satellite would have its two periods tend to equality, and having progressed further in the march of condensation, would be less likely than the planet to experience a later acceleration of rotation. Indeed, the inner planets themselves would seem to have their two periods nearly equal. Thus, in the satellite the conditions would be unfavorable to the formation of an additional series of satellites, and no case of such is known. Roche showed also that, in the rotating mass as postulated by Laplace, there would be a flow of matter, along the surface, from the neighborhood of the poles to the equator, and that this matter, with lower actual velocity than the surface matter near the equator, would tend to become immersed in the atmosphere and form interior rings which would lead to the formation of a planet within the atmosphere. This planet moving within the atmosphere would experience a contraction of its orbit and an increase in the rate of revolution. Another important feature of Roche's work was the establishing of the fact that at a distance from a planet less than two and one-half times its radius a small satellite of approximately the same density would be disrupted.

It is in place now to refer to the work of Sir George Darwin on tidal friction. Laplace and Roche had pointed out certain general results of such action. The importance of tidal friction as an inevitable and powerful influence in the development of planetary systems is the outstanding contribution of Darwin to the theories we are now considering. He worked out his ideas in a series of papers presented to the Royal Society and in his

very interesting work on "The Tides" he has given a simple account of his theory, showing how in particular tidal action must have played a considerable part, and was probably the preponderant influence, in the development of the earth-moon system.

The more important objections to the theory of Laplace will now be considered and the arguments advanced to meet them briefly stated.

(*a*) Modern science has found it difficult to admit the existence of a gaseous nebula with a high temperature, as was contemplated by Laplace as a primitive form of his solar nebula.

For a long time, to this objection, was urged the fact that the telescope reveals what would seem to be such nebulæ, while the spectroscope presented the bright lines characteristic of glowing vapor. It is, however, now generally believed that the tenuous matter of the nebula exists in some such condition as a gas and that the glow is due to electric excitement.

(*b*) The time necessary to the evolution offers certain difficulties.

For the aggregation of a disrupted ring into a planet the time demanded is enormous. Yet to this we may say that we have a long past upon which to draw. When, however, we come to the time during which conditions on the earth could be said to allow the existence of water on the surface, or to be favorable to life, there are rival claims for time that may be checked up one against the other. Sir William Thomson and Helmholz, accounting for the greater part of the sun's heat as the equivalent of the mechanical action of shrinkage in the sun, assigned certain periods as limits to such conditions. These seemed inadequate to the demands of geology and biology. But now the later teachings of science show that in the spontaneous changes which radium and other radio-active substances undergo, we have a hitherto unsuspected source of heat, and this will allow an enlargement of the periods assigned by the physicists, ample enough probably to meet the severest demands of the geologist or biologist.

(*c*) Professor Moulton and Dr. See are of the opinion, or rather insist, that Laplace's hypothesis is rendered untenable through the consideration that in a body condensing under the action of gravity the law of conservation of areas holds, *i. e.*, as a particle draws nearer the attracting centre its velocity increases so as to ensure that the area swept out by a line from the centre to the particle continues to be the same in any given time. Appeal is made to a paper by Babinet in the *Comptes Rendus*, Tome 52. See speaks of the theory there developed as Babinet's Criterion. According to Laplace, when the ring which was the source of the earth was abandoned the nebulous mass was rotating in somewhat the same time as that required for the revolution of the earth about the sun. See shows that if the matter now making up the sun, the inner planets and the earth were distributed uniformly throughout the space reaching out to the earth from the sun, the law of conservation of areas would require the period of revolution of the earth to be 1673 years in place of one year, and so striking a discrepancy must rule Laplace's hypothesis out of court.

The objection would seem to be based upon a complete misunderstanding of Babinet's paper and a disregard of the explicit and repeated statement of Laplace that he developes his system from a central condensed sun with a tenuous atmosphere. Babinet's paper would seem to be written to show that an hypothesis different from that of Laplace would lead to just such disagreements with actual facts as See points out.

(*d*) The rotation of Uranus and Neptune is retrograde, this fact in regard to the former being known to Herschel before Laplace's theory was given to the world, although Laplace would not have been aware of it.

Laplace explained the direct rotation of the planets in the following way. When the ring was left behind it rotated as if it were of one piece, accordingly the outer particles had a greater actual velocity than the inner ones. Hence when the aggregation advanced to completion the outer particles determined by their excess of velocity a direct rotation. Now opinion inclines to the

view, that in the gradual disruption and condensation of vapors into particles and masses, the inner masses, moving as independent bodies and not carried as part of a continuous stream, would in their orbital motion about the central attracting mass have a greater velocity than the outer particles and masses, as is required by Kepler's Third Law. Hence under aggregation, the resulting spheroidal mass would have a retrograde rotation. Then tidal action as suggested and explained by Roche and Darwin would bring the period of rotation and that of revolution to equality and to the same sense, *i. e.*, the retrograde rotation would be gradually changed until it became direct. Then under condensation the rate of direct rotation would increase. In the case of the outermost planets the effect of tidal friction would be small and it seems not to have triumphed over the retrograde motion.

(*e*) In the systems of Jupiter and Saturn the outermost moons revolve in the retrograde sense, while the inner moons have a direct revolution.

Referring to (*d*) we may say that in the earlier history of those systems, the planets had a retrograde motion, and while this was the case they shed the outer rings, which generated the outer moons and their revolutions would be retrograde. Later when tidal friction had turned the scales, other rings were shed, now with a direct rotation and giving rise to moons moving round the parent planet in the direct sense.

(*f*) The inner part of the rings of Saturn, as well as the inner moon of Mars, revolves in a period less than the time of rotation of the parent planet.

This is on the face of it at variance with the ideas of Laplace. But we have seen that Roche's investigations pointed to the formation of rings within the planetary atmosphere. It was shown too that the orbits of the resultant moons would be contracted and the time of revolution diminished. This may be regarded as an extreme or strained modification of the original statement, yet it is a possible explanation of the difficulty.

(*g*) The relatively great size of the moon, and, in relation to

this, its great distance from the earth makes it an anomalous element in the solar system. It has been argued that the earth's atmosphere could have reached only three-quarters of the distance to the moon when the rate of rotation gave a period of 27 days 3 hours, the time of revolution of the moon.

This last statement is inaccurate because it is based on the absolute attraction of the sun, whereas, the sun attracting the earth as well, the relative attraction should have been employed; then the difficulty disappears. Further, Darwin's "Tidal Theory" affords a satisfactory, or at least, a possible explanation of the essential facts of the moon.

Time will not permit the consideration of other objections. The more striking of the difficulties connected with the theory in question would seem in some measure resolved. Yet one may well feel that the adjustments have been too numerous and perhaps somewhat artificial. Many have so felt, and have offered theories, with more or less in common with the older hypothesis. Of these the more striking departures from Laplace's theory are those that are associated with the names of Chamberlin and Moulton, and with the name of See.

If the solar system developed along the lines traced by Laplace, we should expect to find, among the nebulæ, many of spherical or lenticular form with strong central condensation, as well as many showing rings more or less complete left behind by the contracting nebula. It has already been said that the testimony furnished by the telescope at the time of Laplace was to this effect. For a long time it was supposed that this type of nebula, if not the prevailing type, was a sufficiently common one to add to the evidence in favor of the generally accepted theory. In recent years, however, all has been changed. With improved telescopes, and more refined methods, particularly along photographic lines, we have learned that everywhere there are nebulæ and that the great majority of those examined are of spiral form. Very few seem to be of a form fitting in with the evolution sketched by Laplace, indeed none with any real measure of certainty. Thus the Andromeda Nebula, which in photographs taken

not long ago, appeared as a lens-shaped nebulous cloud, with a well-defined large detached ring, and what seemed to be nuclei for planetary condensation, and afforded the argument of fact to the Nebula Theory, is now thought to conform rather to the spiral type. The evidence from without is accordingly disquieting.

Chamberlin, the distinguished geologist, adding to the more generally known objections to Laplace's theory certain objections reached through considering conditions on the earth, was impressed by the great number of spiral nebulæ, and was led to a theory based on the Planetesimal Hypothesis. He early associated with himself his colleague Moulton, the astronomer. Jointly they have worked out the theory in some detail and there are many points in which, according to general opinion, it is more satisfactory than the older theory.

The spiral nebula is assumed to be the form out of which our system evolved, and in accounting for the existence of the spiral form, Chamberlin finds the clue to the later development, although, it must be said the theory of the development is not necessarily based on the argument concerning the origin of the nebula. He postulates the near approach, if not actual contact of two suns as they move through space. Great tidal distortion and tidal stress are induced in each. If we direct attention to one of suns we see protuberances polar to each other, in the direction of the other sun. Under the stress, streams or masses of matter are ejected, much, if not all, of which is retained by the parent sun as the other moves away. The withdrawing sun, however, imposes upon the streaming or ejected matter on each side a motion in the plane determined by the direction in which it is moving. Thus, when the other sun has moved on, we have a sun with two projecting arms each more or less markedly spiral on account of the motion of rotation imposed in greater degree on the more remote parts. The early condensation of separated nebulous masses in the arms into small planets or into dust or meteoric swarms, and the aggregation of the planetesimals into planets under the action of gravity or through collision at the intersections of orbits would seem to be a normal line of advance.

Much of the uniformity that so much impressed Laplace, in the solar system, as the closeness of the planes of the planetary orbits, and the prevalence of direct motions, seems to follow. Yet not a few of the difficulties encountered by Laplace's theory are difficulties in the newer theory. The hypothesis has much to claim our judgment and there are certain terrestrial demands that, as Chamberlin shows, are best met by it. The case is excellently presented in Professor Chamberlin's well-known work on "Geology" and in the *Year Book*, No. 3, of the Carnegie Institution. Many papers by Professor Moulton fortify it on the more purely astronomical side. Necessarily much remains to be done in the way of elaboration, and in the meantime we must see in the hypothesis a bold and original attempt to grapple with a fundamental problem. I shall close this brief sketch of this theory by citing certain facts that involve difficulties. The probability of the disruptive approach of two stars is not high, yet the heavens are studded with spiral nebulæ. Further, where stars are the most numerous, in the region of the Milky Way, these nebulæ are comparatively rare, and where stars are least numerous the density of distribution is highest. Again, the origin claimed for the spiral nebula, makes it possible that they would occur frequently in pairs which seems not to be the case. Last of all, as Hale remarks, it is strange that the small bodies made up of the projected matter of the sun should remain brilliantly luminous for so long a time; strange too that we do not discover incipient spirals giving a bright spectrum.

Dr. See in his great work, "Researches on the Evolution of Stellar Systems," Vol II., developes what he calls the Capture Theory. He supposes a sun with an extended rare atmosphere. Into this atmosphere there come, from without, bodies whose motion becomes controlled by the attraction of the sun; they are *captured* by the sun. As they move in their new orbits, they encounter the resistance of the atmosphere, and, as See shows, these orbits will become smaller and more nearly circular. These bodies, with additional matter swept up by them, become planets. Later, when small bodies enter the atmosphere from without,

they also start on a planetary career, but See shows that the fate of many of these will be to come under the influence of a planet and form satellites; these are captured by the planet. To explain how it is that in our system the planets for the most part have a direct rotation on an axis, See holds that as swarms of dust collide with a planet the tendency is to give the globe just such a rotation. While the theory accounts fairly for the small eccentricities of the orbits of planets and satellites, it does not seem to suggest why the orbits of the planets should lie closely to one another, nor does his argument touching the direct rotation of planets convince.

The question of the genesis of nebulæ and in particular of spiral nebulæ is also considered by See. He thinks that nebulæ are formed through the assembling of particles of dust driven out from the stars by the pressure of light and by the action of electric forces. The nebula is a colony of such matter, ordinarily not at rest. If two such cosmic clouds drift near each other, the nearest parts might very well, under the action of gravity, come into contact or coalesce. The two clouds would then form one nebula. This contingencey is more likely to arise in the case of clouds moving in directions somewhat opposite. After junction the parts that came together would form a nucleus around which the wings, as it were, would rotate in the same sense. Poincaré points out that in this theory of spiral nebulæ there is a grave weakness. There is no reason to assume that the two cosmic clouds are equal in extent or are of similar shape. Yet in actual spiral nebulæ there is a symmetry in the spiral parts for which the origin assigned by Chamberlin accounts.

The brief statement of these newer theories is, I know, quite inadequate, but it would be difficult, in the short time I have, to consider them in greater detail. This must be my excuse also for not touching upon the important contributions to this side of astronomical science of such investigators as Faye, Ligondès, Lockyer, Arrhenius and Belot.

In respect to the different hypotheses, there now arises the question of the one to be accepted. If we reflect that a theory

is less a finality than a unifying or co-ordinating statement, of value mainly as it stimulates intellectual action and leads to wider knowledge, we shall, I think, feel that it is best to keep an open mind towards them all. Indeed, there is little virtue in this choice, for in all of them there are convincing features, in all of them certain points of weakness. In the sciences that have to do with things immediately at hand, and with the actions between them, where we can, as it were, surround the enemy, we know that only the outposts have been taken. Can we wonder then that, in a science in which nearly everything involved is on a transcendent scale, there should be so much withheld? We can, at least, be comforted when we find Darwin hesitating to hold positive opinions, and Poincaré closing his book with the declaration — "Nous ne pouvons donc terminer que par un point d' interrogation."

LOCATION OF EPICENTRES FOR 1911.

By Otto Klotz

EACH earthquake recorded at Ottawa, even if only some long waves (L) were recorded, was compiled with the corresponding records received here from many other stations, and if the data were sufficient, a graphical determination (stereographic method as described heretofore) of the epicentre was attempted. If the reading of each seismogram were correct, and the time reliable there would then be little or no uncertainty of the epicentre; and the described arcs or circles from the stations used would practically intersect at a point. But as the following table shows this is far from being the case, and shows too that there is ample room for improvement not only in seismograms but in the skill of reading them.

The construction was made on our printed forms where the radius of the circle is 10 cm. It is unnecessary to state that the greatest care is exercised in laying off d and r, which are taken from my tables published last year.

There are cases, of course, where the apparent discrepancy in plotting is due to the assumption that the data utilized refer to one and the same quake and epicentre, whereas there may have been two quakes, the second possibly having been set loose by the first. However, the great trouble lies, undoubtedly, with the records and their interpretation.

Where intersections from three or more stations were satisfactory, the geographical co-ordinates of the epicentre are given.

Prince Galitzin has published a list of epicentres determined by him from his own records at Pulkova and these as far as they pertain to those graphically located above are given in an adjoining column. Similarly those determined by Professor Zeissig

by his method of arrival of wave front of the first or *P* waves at his own and at another station are given.

Up to the present it is assumed that the epicentre is surrounded by circular isoseists whether of *P*, *S* or *L* waves. The most of the seismograms, if not all, are yet vested with inaccuracies, sometimes gross, that prevent an analysis of this question.

The question is simply this,— Are the waves of the same kind propagated equal distances, as measured on the surface, in the same time? On this answer depends the proof of homogeneity or otherwise of the earth's interior deduced from the *P* and *S* waves. I do not think that there is at present sufficient reliable data at hand to answer this question satisfactorily. It appears reasonable to believe that the transmission time at any given station for the various kinds of waves to arrive from a given distance, say 5000 km., in any given direction, is not quite the same for any other direction. This conclusion would apply essentially to the earth's crust with its varying geologic formations and faults down to the depth of isostasy, some 122 km. Beyond that we probably get into fairly homogeneous shells, even if we arrive at Wiechert's critical shell at about 1500 km. It may be mentioned that for the above assumed arcual distance of 5000 km., the ordinate to the chord is 485 km.

The outlook for the unravelling of the mysteries of the interior of the earth is promising, and that unravelling will come from the new science of Seismology, but only after we have absolutely reliable data, for which accurate time and highly sensitive instruments are essentials.

If the seismologist had his way, he would ask for a good tectonic earthquake, say once a week, but I hasten to add that he would distribute them from pole to pole so that life and property would not be affected. With a year or two of records from such, the interior would become scientifically translucent.

Fortunately Ottawa is not in nor near a seismic area; the nearest seismic region is the West Indies, some 3000 km. distant, so that we have relatively fewer earthquakes recorded than European stations, with the propinquity of the Mediterranean

earthquake belt extending along the Caucasus into Asia. Hence European stations will in general be able to locate more earthquakes from their records than we can here, because they have more material.

For the determination of distance, the equivalent of the difference of time of the arrival of the *P* and *S* waves, Zeissig's extended table, based on the Zöppritz curve, has been used.

The stereographic plotting has been done by Mr. R. C. McCully of our office.

G and *Z* in the fourth column refer to the co-ordinates given by Galitzin and Zeissig respectively.

Location of Epicentres 1911.

Note.—The figures following a station in the 2nd and 5th columns refer to the distance in kilometres from the respective station to the epicentre.

Date	Stations	Epicentre		Remarks
Jan. 1	Aachen = 4900 Göttingen = 4600 Hamburg = 4560 Tiflis = 2120 Vienna = 4210	φ = 41°38′ λ = 70°12′ E.	Z's φ = 38° λ = 67° E. G's φ = 43°21′ λ = 74°01′ E.	The circles of the five stations given meet almost exactly at the co-ordinates given. Cartuja = 6050 falls about 1mm. short in plotting.
Jan. 3				Data: Vienna = 6170, Graz = 6000, Laibach = 7000, Göttingen = 6765, Cartuja = 4670. Intersections unsatisfactory.
Jan. 3-4	Ottawa = 9800 Pulkowa = 3090 Strassburg = 5300	φ = 43°40′ λ = 78°20′E.	G's φ = 42°59′ λ = 78°00′E.	
Jan. 7				Data unsatisfactory: Manila = 2750, Batavia = 3025, Tiflis = 9050, Belgrade = 7450, Vienna = 6900, Laibach = 7700.
Feb. 5	Harvard = 3470 Ottawa = 3550 St. Boniface = 3840	φ = 15°44′ λ = 90°15W.		Göttingen only eastern station available but distance = 9000 throws adjoining epicentre considerably east.
Feb. 18	Cartuja = 6550 Hamburg = 4830 St. Boniface = 9825 Tiflis = 2425	φ = 41°24′ λ = 74° E.		These stations give very close intersections.
Feb. 26				Data: Belgrade = 7500, Göttingen = 6750, Cartuja = 4650. Intersections unsatisfactory.
Apr. 7	Cartuja = 10090 Hamburg = 8050 Vienna = 8540	φ = 51°56′ λ = 166°55′E.	G's φ = 52°48′ λ = 166°52′E.	Cartuja = 10090 Manilla = 3470, Vienna = 8540,

Location of Epicentres 1911.

Date	Stations	Epicentre		Remarks
				give $\varphi = 3°50'$ $\lambda = 90\,43'$E. Graz = 8250 only other station available agrees with neither. *S* of Graz and *P* of Manila check out quite closely with $\varphi = 51°\,50'$, $\lambda = 165°\,55'$ E.
Apr. 10	Cartuja = 7710 Hamburg = 8750 Ottawa = 3240	$\varphi = 10°04'$ $\lambda = 75°07'$W.	Z's $\varphi = 16°$ $\lambda = 79°$W.	Checked satisfactorily by Vienna = 9250, and by Aachen = 8550.
Apr. 18	Aachen = 4575 Manila = 7625 Tiflis = 1920	$\varphi = 24°40'$ $\lambda = 48°03$E.		Göttingen = 4300 comes quite close. Batavia = 6650 does not agree.
Apr. 28				Data: Vienna = 8370, Graz = 8490, Laibach = 2990, Hamburg = 8225, Cartuja = 7025, Harvard = 4875, Ottawa = 5475, St. Boniface = 5425. Harvard, Ottawa, Hamburg and Vienna give small quadrilateral which gives $\varphi = 0°58'$, $\lambda = 53°20'$W but position uncertain.
May 4-5	Cartuja = 9170 Göttingen = 8000 Tiflis = 8325	$\varphi = 55°52'$ $\lambda = 170°$ E.	Z's $\varphi = 52°30'$ $\lambda = 157°$E.	A good intersection but the other circles intersect in the vicinity of $\lambda = 154°$ to 160° E.
			G's $\varphi = 52°24'$ $\lambda = 153°12'$ E.	
	Aachen = 8000 Cartuja = 9070 Ottawa = 7765	$\varphi = 55°$ $\lambda = 158°$E.		Not as good an intersection as the above.
May 9				Data: Graz = 3750, Cartuja = 8260, Hamburg = 4000, Harvard = 4160, Ottawa = 7000, Göttingen = 3750.

LOCATION OF EPICENTRES 1911.

Date	Stations	Epicentre		Remarks
				No epicentre located. Intersections very scattered.
June 7	Aachen = 9650 Cartuja = 9565 Ottawa = 3725 St. Boniface = 3410	$\varphi = 19^\circ 42'$ $\lambda = 104^\circ$ W.	G's $\varphi = 19^\circ 34'$ $\lambda = 97^\circ 59'$ W.	Göttingen = 9850 agrees quite closely.
June 8	Cartuja = 4560 Gottingen = 3075 Strassburg = 3250	$\varphi = 44^\circ 32'$ $\lambda = 50^\circ 28'$ E.	G's $\varphi = 41^\circ 25'$ $\lambda = 50^\circ 06'$ E.	
June 15	Batavia = 4340 Cartuja = 10820 is = 7200	$\varphi = 29^\circ 30'$ $\lambda = 125^\circ 29'$ E.	Z's $\varphi = 31^\circ$ $\lambda = 125^\circ$ E.	Hamburg = 8850 checks the result quite closely. Ottawa = 9400 discordant.
July 1	Cartuja = 9430 Hamburg = 9000 Ottawa = 3600	$\varphi = 33^\circ 20'$ $\lambda = 114^\circ 50'$ W.		Vienna = 9350 and Graz = 9230 do not fit in with adjoining epicentre.
July 4	Cartuja = 6500 Hamburg = 4820 Manila = 5300	$\varphi = 42^\circ 58'$ $\lambda = 75^\circ 50'$ E.	Z's $\varphi = 30'$ $\lambda = 72^\circ$ E.	Aachen = 5150 checks the result closely.
July 12			Z's $\varphi = 18^\circ$ $\lambda = 126^\circ$ E.	Data unsatisfactory: Belgrade = 9300, Vienna = 10200, Gottingen = 8750, Hamburg = 9600, Jugenheim = 9900, Strassburg = 10750, Harvard = 11075, Ottawa = 10900, St. Boniface = 8100, Intersections fall far apart.
Aug. 16	Aachen = 9950 Manila = 2850 Ottawa = 10600	$\varphi = 31^\circ 24'$ $\lambda = 142^\circ 28'$ E.		Vienna = 9850, falls fairly close. Gottingen = 9075, falls not so close.
Aug. 27	Gottingen = 9125 Ottawa = 3475 Strassburg = 9250	$\varphi = 31^\circ 59'$ $\lambda = 112^\circ 15'$ W.		Cartuja = 9075, Vienna = 8850, do not agree with adjoining epicentre.
Sep. 6	Aachen = 7850 Hamburg = 7450 Gottingen = 7700 Ottawa = 8500	$\varphi = 52^\circ 58'$ $\lambda = 143^\circ 20'$ E.		Harvard = 9900 only western station available except Ottawa, does not agree.

Location of Epicentres 1811

Date	Stations	Epicentre	Remarks
Sep. 13			Cartuja = 6800, Hamburg = 7650, Vienna = 8250, only available stations No solution.
Sep. 15			Data available: Belgrade = 10450, Hamburg = 10350, Göttingen = 10050, Strassburg = 9950, Aachen = 9900, Cartuja = 9500, Harvard = 6850, Ottawa = 7200, Cleveland = 7600, St. Louis = 5500, St. Boniface = 4250, Intersections unsatisfactory. Circles cut from 150° to 180° W about 40° N.
Sep. 17	Manila = 2450 Strassburg = 10150 Vienna = 9850	φ = 28° 14′ λ = 140° 30′ E.	Rather unsatisfactory as Hamburg = 8350, St. Louis = 7000, St. Boniface = 5700, do not confirm the adjoining.
Sep. 22	Cleveland = 4775 Ottawa = 4735 Vienna = 7825	φ = 60° 26′ λ = 146° 30′ W.	Harvard = 5230 confirms this result.
Oct. 6	Aachen = 7550 Göttingen = 7850 Ottawa = 3100 St. Louis = 2950	φ = 17° 44′ λ = 71° W.	Reported from Port au Prince. Belgrade = 8800, Hamburg = 7700, Cartuja = 7100, Harvard = 2650, give intersections in the vicinity of, but not close to the adjoining epicentre.
Oct. 10	Ottawa = 3800 St. Louis = 3000 Strassburg = 9200 Vienna = 9750	φ = 12° 02′ λ = 84° 36′ W.	Hamburg = 8800, Cartuja = 7350, do not agree very well with the adjoining.
Oct. 13	Aachen = 8650 Belgrade = 8850	φ = 48° 34′	Tiflis = 10750, Göttingen = 7700,

LOCATION OF EPICENTRES 1911

Date	Station	Epicentre		Remarks
	Helwan = 9750 Ottawa = 8350 Strassburg = 8800 Vienna = 8650	λ = 157°35′E.		Cartuja = 9950, differ from the adjoining.
Oct. 14				Data: Belgrade = 4500, Vienna = 8750, Laibach = 7400, Göttingen = 8750, Strassburg = 8800. Intersections unsatisfactory. Circles very nearly tangent.
Oct. 29				Data: Laibach = 11700, Heidelberg = 7050, Harvard = 6600, Ottawa = 4700, St. Louis = 3250, St. Boniface = 4150. Intersections unsatisfactory.
Nov. 1				Data: Laibach = 10250, Harvard = 3750, Ottawa = 4050, St. Boniface = 4000. Intersections unsatisfactory. Reported from San Juan.
Nov. 13				Data: Helwan = 8200, Laibach = 9100, Hamburg = 8000, Göttingen = 9000, Strassburg = 8750, Aachen = 8350, Intersections unsatisfactory. Circles very nearly tangent.
Nov. 20				Data: Vienna = 9150, Laibach = 7750, Ottawa = 2550, St. Louis = 2350, St. Boniface = 4850. Intersections unsatisfactory.

Location of Epicentres 1911

Date	Station	Epicentre	Remarks
Dec. 16	Hamburg = 9650 Harvard = 3900 Ottawa = 3800	$\varphi = 19^{\circ}\ 10'$ $\lambda = 102^{\circ}15'$ W.	Cartuja = 9400 agrees with the adjoining. Vienna = 9600, Laibach = 9500, Göttingen = 9600, Aachen = 9750, St. Louis = 2750 do not accord with adjoining. Reported from Acapulco Mex.
Dec. 20			Data: Vienna = 9200, Laibach = 9350, Hamburg = 8200, Göttingen = 9000, Aachen = 8600. Intersections unsatisfactory. Circles very nearly tangent.
Dec. 22	Ottawa = 3850 Cartuja = 9400	$\varphi = 17^{\circ}26'$ $\lambda = 100^{\circ}30'$ W.	Hamburg S fairly accordant. Vienna = 8900, Aachen = 4300, St. Boniface = 9200, differ widely from adjoining. Reported from Mexico.

Dominion Observatory,
Ottawa, Canada.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA. WASHINGTON MEETING, DECEMBER 27-29, 1911.

By C. A. Chant

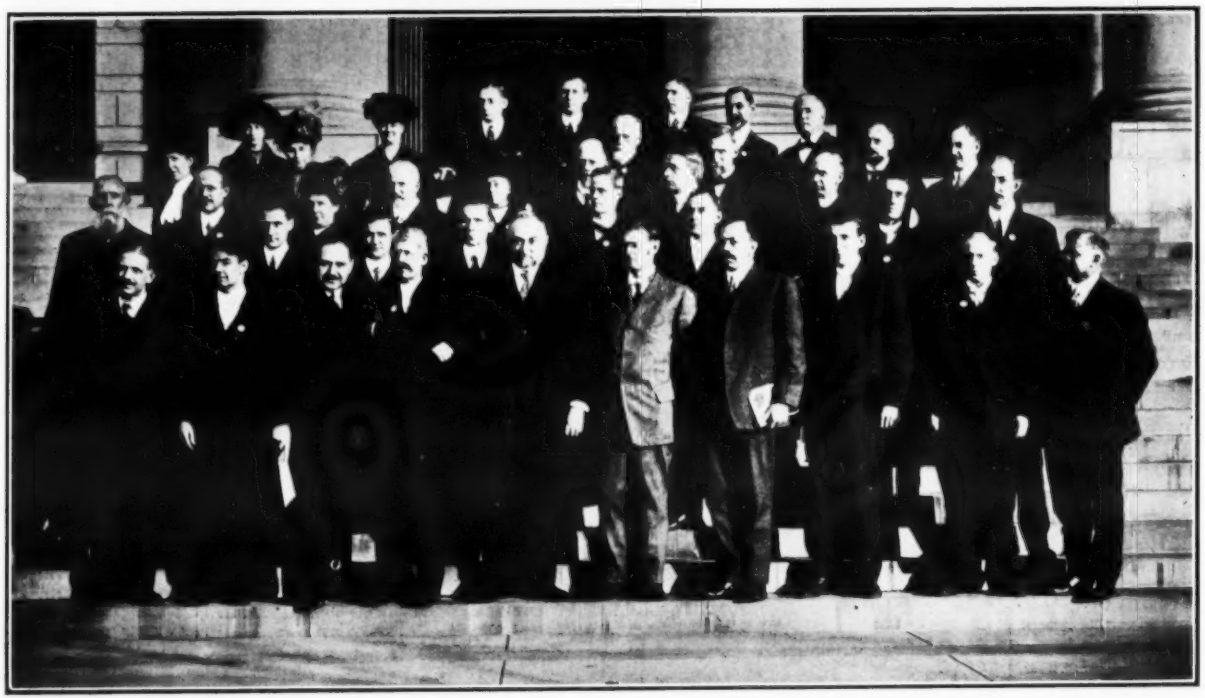
DURING the week between Christmas and New Year's the American Association for the Advancement of Science holds its annual meeting. Affiliated with this great and representative organization are numerous societies, one of which is the Astronomical and Astrophysical Society of America; and although the regular annual meeting of the Society is held in August, the advantages to be gained from convening with a great number of workers in other branches of science were considered sufficient to call a meeting for the same time.

Section A of the American Association is devoted to Mathematics and Astronomy, and it was fortunate for the Association that the Society had arranged for a meeting. The American Mathematical Society met at the same time in New York and drew practically all the mathematicians away. With the exception of one paper, namely the vice-presidential address of Section A by Professor E. H. Moore, of Chicago, all the papers were supplied by the Society.

The attendance was about 65, a good average, and of these Chief Astronomer King, Mr. J. S. Plaskett and the writer were from Canada. The meetings were held in the assembly room of the building erected for the headquarters of the Carnegie Institution of Washington.

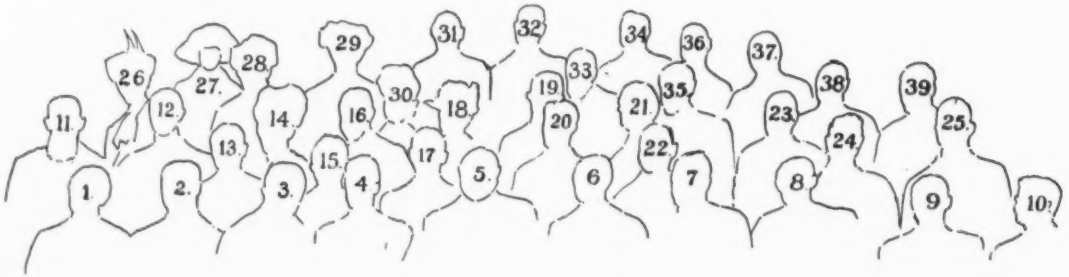
On the afternoon of the 27th a reception was given by President and Mrs. Woodward, of the Carnegie Institution, and the many interesting exhibits of the different branches of the Institution's work were examined by the visitors.

On the evening of Thursday the 28th a reception was tendered by the Superintendent and Staff of the United States Naval



THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

Group on the steps of the Carnegie Institution Building, Washington, D.C., December 29, 1911.



Key to Plate II.

1. W. M. Hamilton
2. S. G. Barton
3. F. Schlesinger
4. A. N. Skinner
5. E. C. Pickering
6. E. B. Frost
7. J. S. Plaskett
8. E. Doolittle
9. D. T. Wilson
10. G. H. Peters
11. C. L. Doolittle
12. F. B. Littell
13. H. R. Morgan
14. Miss A. J. Cannon
15. F. E. Ross
16. R. W. Willson
17. C. A. Chant
18. Miss Lowater
19. A. Hall
20. H. B. Hedrick
21. H. N. Russell
22. H. S. Davis
23. W. F. Rigge
24. A. T. J. Apple
25. W. M. Mitchell
26. Miss H. W. Bigelow
27. Miss Leah Allen
28. Miss M. Hopkins
29. Mrs. Snow
30. Miss M. Proctor
31. — Rines
32. — Snow
33. E. Frisby
35. F. H. Loud
36. W. S. Eichelberger
37. E. E. Barnard
38. E. W. Brown
39. A. B. Turner

Observatory. This was largely attended and was a very enjoyable function. During the evening the various buildings of the Observatory were open for inspection, and the writer had the pleasure of viewing Saturn through the great 26-inch refractor, which was in charge of Professor Asaph Hall, the son of the astronomer who discovered the satellites of Mars with the same instrument in 1877.

On Friday evening, after the last session of the Society, the members and their friends were received by Professor and Mrs. Edgar Frisby at their home on 31st St. Professor Frisby was born in England, was educated in Canada, graduating from the University of Toronto in 1863, and spent most of his active life on the staff of the United States Naval Observatory, retiring from it at the legal age. A very enjoyable time was spent.

The following papers were read:

E. W. Brown.—"A device for facilitating various forms of computation."

H. S. Davis.—"The Astronomischer Jahresbericht: an announcement."

H. S. Davis.—"The lesson of Joseph Piazzi's life."

Joel Stebbins.—"The variability of Polaris."

J. H. Metcalf.—"The asteroid problem."

J. A. Parkhurst.—"Magnitudes, colors and spectra of standard stars within seventeen degrees of the North Pole."

J. G. Porter.—"A comparison of Doctor Peter's Celestial Charts with the photographic charts of the sky."

G. H. Peters.—"The new twin photographic telescope of the United States Naval Observatory.

Miss S. F. Whiting.—"The use of special topics in teaching astronomy."

E. B. Frost.—"Spectrographic Observations."

J. C. Duncan.—"The orbit of the Spectroscopic binary Beta Scorpii."

Frederick Slocum.—"The dissolution of solar prominences."

Frederick Slocum.—"The parallax of Nova Lacertae. (1910)."

W. J. Humphreys.—"A simple pyrheliometer."

F. W. Very.—"The Violle actinometer as an instrument of precision."

Annie J. Cannon.—"The revised Draper catalogue."

H. N. Russell.—"Notes on the calculation of the elements of Algol variables."

H. N. Russell.—"The eclipsing variables, W Crucis and W Ursæ Majoris."

J. S. Plaskett.—"The solar rotation."

F. E. Ross.—The moon's mean parallax."

Eric Doolittle.—The secular variations of the elements of the orbits of the four inner planets."

C. F. Talman—(Introduced by W. J. Humphreys). "The language of meteorology."

F. H. Loud.—"May astronomy derive any benefit from the dissemination of Esperanto?"

W. S. Eichelberger and *H. R. Morgan.*—"On the flexure of a meridian circle."

E. S. King.—"Tests with standard electric lamps."

J. A. Brashear.—"Recent interviews with optical glass manufacturers of France and Germany."

E. E. Barnard.—"Some observations with the 60-inch reflecting telescope of the Mt. Wilson Solar Observatory."

E. E. Barnard.—"Photographic observations of Brook's Comet of 1911."

Mr. Plaskett's paper gave a summary of measurements of the period of the sun's rotation by spectroscopic methods. The results obtained at Ottawa agree in a general way with the law of variation of the period with solar latitude, but show no indication whatever that the period given by one substance (as lanthanum) is different from that for any other.

Perhaps the most striking, from the point of view of the general student of Astronomy, was Professor Barnard's paper on "Some Observations with the 60-inch reflecting telescope of the Mt. Wilson Solar Observatory." Professor Barnard said that for some reason, which he could hardly explain, he had been prejudiced against reflectors for visual observations, but his experience with the 60-inch reflector on Mt. Wilson had convinced him that it was in no wise inferior to a refractor. The great value of the reflector for photographic purposes was well known, and Professor Barnard illustrated this by exhibiting some magnificent pictures of Saturn and Mars which he had taken during the autumn of 1911.

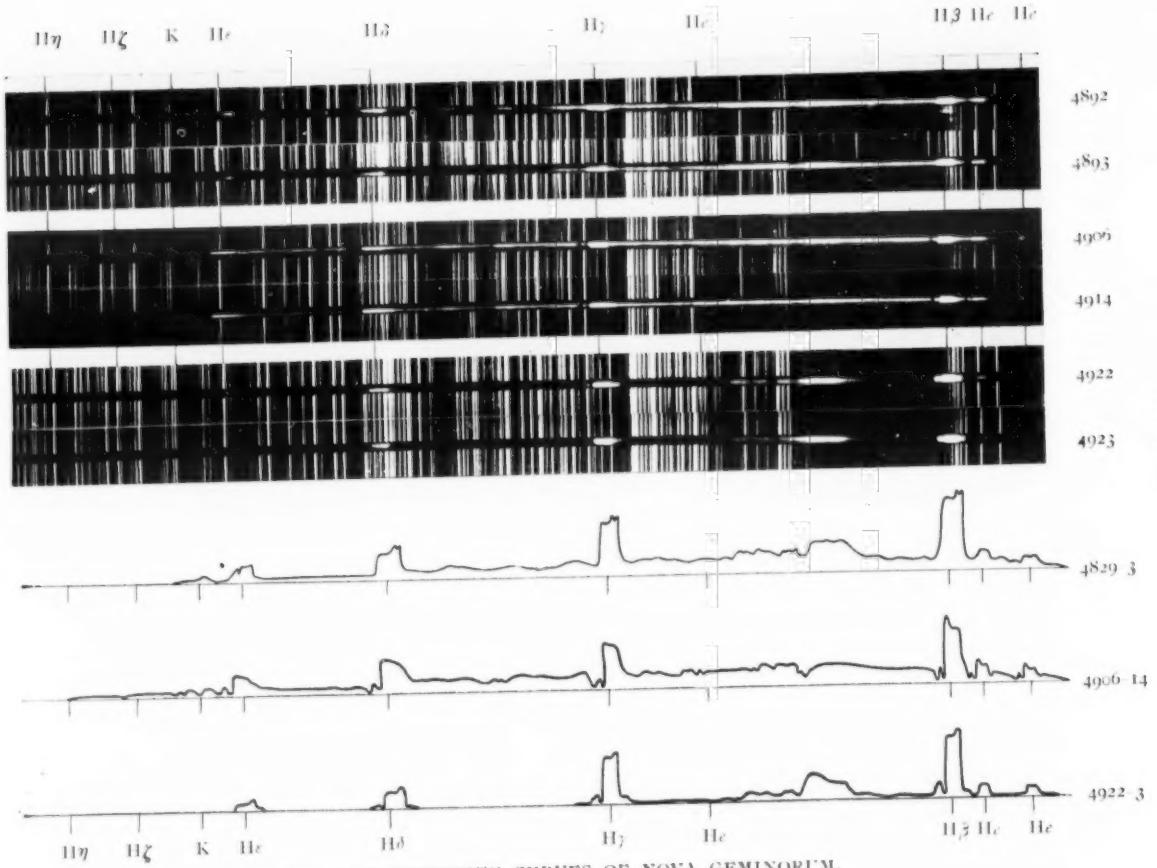


PLATE III

SPECTRA AND INTENSITY CURVES OF NOVA GEMINORUM.
By J. S. Plaskett, Dominion Observatory, Ottawa. Enlarged 4 times.

THE SPECTRUM OF NOVA GEMINORUM*

By J. S. Plaskett

THE new star in the constellation Gemini, R.A. $6^h\ 49^m$, Dec. $+ 32°\ 13'$, about 2° south of θ Geminorum, which was discovered by Enebo in Dombaas, Norway, on March 12, was announced by telegraph from Harvard Observatory on March 13. There was some mistake and delay in the first message so that no spectra were obtained at Ottawa until March 18. It is unfortunate, owing to the marked changes that have occurred in the spectrum since discovery, that some earlier plates were not secured but those since obtained show very considerable changes in the nature of the emission and absorption bands, which it is the purpose of this paper to describe.

To the date of writing, seven spectra of the Nova have been photographed, three on March 18 and one each on March 22, 25, 27, 29. These have all been made with the single prism spectrograph of the Dominion Observatory, the one regularly employed in radial velocity work, which gives a linear dispersion of 33·5 Å per millimetre at H_γ. The observing data are given in the following table.

DATA OF OBSERVATION

Plate Number	G. M. Date	Hour Angle at End	Duration of Exposure	Remarks
		h m	m	
4892	March 18·56	2 11 W.	110	Partly cloudy and hazy.
4893	" 18·63	3 20	59	Seeing improved.
4894	" 18·67	3 40	15	Seeing improved.
4906	" 22·53	1 54	113	Seeing fair
4914	" 25·54	2 20	120	Seeing fair.
4922	" 27·56	4 05	150	Cloudy and poor.
4923	" 29·56	3 05	125	Windy.

A comparison of these plates shows that, although all are of the typical Nova form, considerable change has taken place in the

* This issue of the JOURNAL was held over in order to include this timely article.—EDITOR.

By J. S. Plaskett, Dominion Observatory, Ottawa. Enlarged 4 times.

character of the spectrum, which can be divided into three distinct types.

The first of these includes plates 4892-3-4 made on March 18. These spectra show emission bands of hydrogen, helium and calcium, as well as a number of fainter bands whose origin is uncertain. The strongest of these bands, those of the β, γ and δ lines of hydrogen, show double maxima of intensity at the red side of the band, while all the bands seem stronger on the same side. The absorption lines or bands usually accompanying the emission in the spectra of Novæ are, however, very faint and diffuse, barely recognisable, let alone accurately measurable on the plates. The continuous spectrum is relatively strong and the contrast between it and the gradually shaded edges of the emission bands is not sharply marked, rendering it difficult to certainly determine the boundaries of the latter. A number of more or less sharp metallic absorption lines are also present, the H and K of calcium being especially well marked, while the magnesium λ4481, some three or four of iron and others of unknown origin are in decreasing order of distinctness,

The second of the types is followed in plates 4904 and 4916 obtained on March 22 and 25. In these the contrasts between continuous emission and absorption spectra are much more sharply defined, and although the continuous spectrum is about equal in relative intensity to that in the first type, the presence of strong absorption lines renders the measurement more certain and accurate. The characteristic feature of these plates is the strong moderately broad and sharply defined pair of absorption lines at the violet side of most of the emission bands which shade off gradually on the red side. So pronounced and generally prevalent are these lines, that a faint pair served to prove the presence of the helium λ4472, which was not accompanied by any visible emission. The narrow absorption lines H and K and two or three of iron are still present.

The principal change occurring in the third type, present in plates 4922-3 on March 27 and 29, is the increasing contrast between the continuous and the emission spectrum. The former has

become relatively weak and possibly for this reason the second one of the pair of absorption lines of the previous type has disappeared. The emission bands now consist of a strong sharply defined central portion some 25 Å wide with weak shaded portions on each side, separated, at least on the violet side, from the central band by absorption. Owing to weaker continuous spectrum and probably insufficient exposure the calcium H and the magnesium λ4481 are the only sharp absorption lines present and these are not so accurately measurable as formerly.

A very good idea of the character of all these spectra can be obtained from their reproductions, assisted by the drawn intensity curves on the plate, but a definite idea of the positions of the bands and lines and the relations in the successive types can best be obtained from the measures which are herewith tabulated.

MEASURES

4892-3	4906	4914	4922	4923	Means	Remarks
5035·0	5035·9	5038·9	5030·4	5030·5	5030·5	Beg. em., abs.
5017·3						Abs. bd. (ft.)
			5007·2	5009·2	5008·2	Min.
5003·7	5003·2	5005·2			5004·0	End em. Abs. line.
	4993·2	4994·8			4994·0	Brd. abs.
			4974·4	4982·5	4978·4	Indef. end em.
4909·4						Beg. ft. bd.
4056·7						End ft. bd.
4940·2	4911·3	4943·4	4933·0	4938·9	4940·6	Def. beg. em., abs. line.
4912·8	4910·4	4911·3	4913·2	4911·5	4911·8	Def. end em., abs. line.
	4900·9	4900·5			4900·7	Brd abs.
4883·6		4887·5	4889·0	4890·2	4887·5	Def. beg. em. Abs. line ?.
	4878·2		4877·3	4878·0	4877·6	Def. increase em.
4874·4						
4871·3			4872·8	4872·3	4872·7	Maxima em.
4863·9			4864·9	4863·6	4864·2	Indef. min. Abs. line.
4850·9						Abs. line.
	4847·2	4847·9	4849·0	4847·5	4847·9	Def. end em. Abs. line.
4842·5	4839·8	4838·4			4837·6	Abs. line.
			4835·9	4836·2	4836·0	End. ft. em. Abs. line ?.
4750·6						Ft. abs. bd.
4084·8				4682·7	4683·7	Indef. increase. Beg. bd.
				4671·1		Increase in em.
4040·1						Max. em.
4033·8						Ft. abs. bd.
4028·5				4628·5	4628·5	Max. em.
4611·2	4611·4	4608·6	4606·6		4609·5	End em. Abs. line.
	4600·6	4598·5			4599·5	Abs. line (ft.).

MEASURES.—(*Continued*)

4892·3	4906	4914	4922	4923	Means	Remarks
4596·5			4596·7	4597·1	4596·8	Beg. em.
4594·8						Strong max.
4589·3			4588·7	4587·2	4588·4	Indef. abs.
4570·7	4568·1?	4572·3	4571·7	4571·1	4571·5	Abs. line.
		4562·0			4562·0	Abs. line.
				4564·3		Beg. em.
4560·1			4560·0	4560·3	4560·1	Max.
4556·1						Abs. line.
4545·2	4548·3				4546·7	Abs. line.
4538·1	4537·3		4540·3	4538·1	4538·4	End em. Abs. line.
4528·2	4528·1				4528·2	Abs. line.
			4536·2	4534·7	4535·4	Beg. em. bd.
4522·7						Abs. bd.
	4510·7					Abs. line ?.
4504·8	4503·9		4507·5	4508·0	4506·0	End em. Abs. line.
4496·2						Abs. bd.
4481·7			4481·1	4481·0	4481·3	Abs. line (*Mg.* 4481).
		4459·5			4459·5	Abs. line.
	4451·0	4449·6			4450·3	Abs. line.
	4405·3					Ft. abs. line (*Fe* 4405).
4392·9						Ft. abs. line.
4381·7						Ft. abs. line.
	4383·5					Ft. abs. line (*Fe* 4343).
4372·8						Ft. abs. line.
4371·0			4365·3	4365·9	4365·6	Beg. ft. em.
4357·4	4354·1	4352·6	4354·5	4354·2	4354·6	Def. increase em.
4352·0						
4350·8			4349·9	4350·1	4350·7	Maxima em.
4342·2			4341·6	4342 8	4341·6	Indef. min. Abs. lines.
4339·8						
4328·5	4328·0	4328·7	4329·7	4329·5	4328·9	Abs. line.
	4319·0	4320·4	4317·7	4318·8	4318·8	End em. Abs. line.
4325·9						Abs. line (*Fe* 4326).
4320·9						Beg. em. bd. (ft.).
4301·0						Max. em. bd.
4286·3						End em. bd.
4249·5	4248·3				4248·9	Beg. ft. em.
4234·5						Max.
4228·0						Abs. min.
4221·6	4222·3				4221·9	End em. abs.
4190·7						Beg. em. (ft.).
4177·7						Abs. min.
4162·1						End em.
4123·3	4123·2		4125·4	4121·2	4123·3	Indef. beg. ft. em.
4115·0	4115·1		4114·8	4114·3	4114·8	Def. increase em. Abs. line.
4112·2						
4110·1			4110·7	4107·5?	4110·7	Maxima em.
4101·7		4101·6	4101·6		4101·2	Indef. min. Abs. lines.
4100·2						
4090·7	4090·0	4090·6	4091·3	4089·6	4090·4	Abs. line. Def. end em.
	4081·6	4082·3	4081·3		4081·8	Abs. line. End ft. em.

MEASURES.—(*Continued*)

4892-3	4906	4914	4922	4923	Means	Remarks
3985·9	3983·4		3934·2	3983·0	3984·1	Indef. beg. em.
3978·7				3978·7	3977·9	Maxima em.
3976·3						
3968·5	3968·6	3968 7	3963·9	3968·7	3968·7	Abs. line (H).
3959·1	3958·3	3957·5			3958·3	End em. Abs. line.
	3950·7	3950·2			3950·4	Abs. line (Brd.).
3949·3	3950·7	3950·2			3949·6	Beg. em. bd.
3933·8	3933 8	3933·8			3933·8	Abs. line (K).
	3922·0	3922·3			3922·2	Brd. abs. line.
		3914·9			3914·9	Brd. abs. line.
	3878 0	3878·4				Abs. line.
	3870·4	3870·9				Abs. line en l em.
	3826·8					Abs. line.

Besides the measures given above, measures of a number of sharp absorption lines used in determining the velocity of the absorbing atmosphere are given in the table of velocities below. A few other faint absorption lines, present for the most part in spectra 4892-3, were measured, but as they were very faint and uncertain and could not be identified with any elements which could reasonably be expected to be present and as some are likely due to photographic defects in the film, they have not been given in the tables.

The different groups of emission and absorption lines and bands are bracketed together in the last column of the preceding table, indicating as far as possible the connection of the measures.

Some of the data contained in this table have been further classified and grouped in the following table for the purpose of determining the normal wave lengths of the sources of emission and absorption present. These two tables serve to show that although the character of the spectrum has changed materially, this is rather a change in the physical conditions producing the spectra than any change in constitution.

The wave lengths of the principal emission bands have been obtained by comparing the measures of the unknown bands with those of the bands which we definitely know are due to the β, γ

and δ lines of hydrogen. If we examine the spectra and intensity curves of the three groups of observations in the accompanying plate we see that each known emission band in each group has definitely measured positions of certain criteria which may, on comparison with the positions in unknown bands, which are frequently faint and also overlap one another, enable the wave length of the source to be accurately determined. For example, we find in the first group (plates 4892-3) the hydrogen emission, consisting of strong broad bands about 40 Å wide with fairly definite edges and having a well defined double maximum at the red edges about 10 Å from the normal position of the line. In the second group (plates 4906, 4914) we have the emission bands shading off more or less gradually to the red, but sharply limited on the violet side by a pair of strong absorption lines about 10 Å apart and the nearest about 12 Å to the violet of the normal position. In the third group (plates 4922-3) the emission is composed of a strong central band nearly 20 Å wide limited, at least to the violet, by an absorption line and with weaker strips 10 Å wide on each side. There are traces also, especially in the first and last groups, of broad faint absorptions not far from the normal positions of the lines.

Proceeding then to tabulate these criteria in parallel columns, with the known wave lengths of the β, γ and δ lines opposite, we readily obtain the wave lengths of the unknown emissions from three sources by direct proportion, making allowance for the changes in width and distance as we proceed along the spectrum. We find the very curious relation, previously found in Nova Persei,* that the widths and displacements of the bands are directly proportional to the wave lengths. The values obtained by these three methods are given in parallel columns, followed by the weighted mean, the probable source and the true wave length.

* Campbell and Wright, *Astrophysical Journal*, XIV., 276.

DETERMINATION OF WAVE LENGTHS

W. L. Known Bands	Def. Limits Emission Bands	Computed W. L.	Pair of Abs. Lines	Computed W. L.	W.L. from Max. and Min.	Weighted Mean W. L.	Source	Normal W. L.
	5036·5	5019·0	5004·0	5016·7	5016·3	5017·0	He	5016·0
	5004·0		4994·0					
	4996·4	4975 ?				4973 ?	?	
	4956·7	4971 ?						
	4940·6	4925·1	4911·8	4923·8		4924·3	He	4922·2
	4911·8		4900·7					
	4877·6	4861·6	4847·9	4861·0	4861·4	4861·3	H	4861·5
4861·5	4847·9		4837·6					
	4683·7	4669·5	4669·5	4622·2	4629	4669·5	?	
	4609·5	4621·5	4599·5			4624	?	
	4596·8	4583·2	4571·5	4583·5	4584	4583·5	?	
	4571·5		4562·0					
	4560·1	4548·4	4538·4	4550·8	4549·5	4548·5	H ?	4544
	4538·4		4528·2		4545·5			
	4535·4	4519·5	4510·7	4521·0	4522	4520·7	?	
	4506·0		4503·9?					
			4459·5	4471·2		4471·2	He	4471·7
			4450·3					
4340·6	4354·6	4340·7	4328·9	4341·7	4340·6	4341·0	H	4340·6
	4328·9		4318·8					
	4320·9	4302·2				4300	?	
	4286·3	4298·6						
	4248·9	4234·1			4227·0	4229·5	Ca?	4227
	4221·9							
	4190·7	4175·3			4176·5	4176	?	
	4162·1							
4101·9	4114·8	4101·6	4090·4	4101·3	4100·5	4101·1	H	4101·9
	4090·4		4081·8					
	3984·1	3970·2	3958·3	3968·3		3969·3	H	3970·2
	3958·3		3950·4				Ca	3968·6
	3949·6	3934·8	3922·2	3931·5		3933·1	Ca	3933·8
	3922·2		3914·9					
			3878·2	3887·8		3887·8	H	3889·1
			3870·6					
			3826·8	3835·8		3835·8	H	3835·6
			. . . .					

The foregoing table shows the unmistakable presence of the hydrogen series from H_ζ to $H\eta$ inclusive and of three lines of helium λλ5016, 4922 and 4472. Although the computed wave lengths of the first two are slightly greater than the normal, this is not to be wondered at when their faintness and their position near the limit of sensitiveness of the plates are considered. The position of λ4472, for which no evidence of emission appears and which is computed only from the faint pair of absorption lines on plate 4914, agrees very closely with the normal, and forms

corroborative evidence that the other lines above mentioned are due to helium. There is a possibility that the line computed at 4548 may be due to the line 4544 of the additional hydrogen series and also that the faint band at 4229·5 may be due to calcium at 4227. No identifications which seemed probable have suggested themselves for the other lines and they are hence left unclassified. Of the 19 probable emission and absorption bands we have 6 due to hydrogen, 3 to helium, 2 (possibly 3) to calcium and possibly 1 to the additional hydrogen series, leaving 6 totally unidentified.

It must not be forgotten, however, that we have a number of sharp absorption lines due to calcium, magnesium and iron, only slightly displaced from their normal positions, probably by the motion of the star in the line of sight. The velocities given by each of these lines, with the mean velocities of the plates and the corrected velocities with respect to the sun, are given in the accompanying table.

VELOCIETIES FROM SHARP ABSORPTION LINES

Element	Wave Length	4892		4893		4905		4914		4922		4923	
		Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.
Fe ?	4529	2	+ 2·4	1	+ 6·3								
Mg	4481	1	101·8	3	41·8					2	+ 10·6	1	+ 34·8
Fe	4405					1	+ 37·9						
Fe	4384					½	17·3						
Fe	4326			2	46·1								
Fe	4308					½	8·0						
H	4102			1	41·3								
Ca	3969	3	51·2	2	42·2	3	33·2	3	39·2	2	+ 29·3	2	+ 43·6
Ca	3934	3	+ 51·7	3	+ 52·1	4	+ 35·1	3	+ 39·3				
Wt'd. Mean			+ 51·5		+ 48·2		+ 34·1		+ 39·2		+ 29·3		+ 43·6
Cor. to Sun			− 29·1		− 29·2		− 29·5		− 29·7		− 29·9		− 29·9
Rad. Vel.			+ 22·4		+ 19·0		+ 4·6		+ 9·5		− 0·6		+ 13·7

The mean velocities are obtained from considering only the H and K lines, as they are the only ones that appear in all the plates, and as they are by far the best and sharpest absorption lines. It is probable that the identification of the line 4529 as the iron line 4528·798 is not correct, for in order to make the

velocity correspond with that given by the other lines the wave length would be only about 4528·1. The magnesium line seems also to give discrepant values, but as the line is faint and not very sharply defined on the spectra it is not surprising. There is, however, no doubt in my mind that there is sharp metallic calcium, magnesium, iron absorption in the spectrum, produced presumably by a layer of metallic vapor surrounding the hotter incandescent material which gives rise to the emission and continuous spectrum.

It would appear as if this metallic atmosphere was varying in velocity, although I do not consider the evidence as quite sufficient to prove variability. Owing to trouble with the temperature case, there was a greater fall of temperatures than desirable during some of the exposures, but as it was always in the one direction and compensated by numerous comparison exposures the relative error introduced should not be large. If we consider the velocity as constant and take the mean (giving the last two half weight) we find a velocity of recession of 12·4 km. per second. The probable error of a plate then comes to nearly 6 km. per second which is much too high for the character of the lines measured and their internal agreement in the plates.

It, therefore, looks as if there might be a small range of velocity very much of the same character as that found in the class of spectroscopic binaries in which the diffuse lines give a high range of velocity and the sharp H and K are either constant or vary over a relatively low range.

The results obtained from the measures of six spectra of Nova Geminorum No. 2 obtained between March 18 and March 29 inclusive may be summarized as follows:—

1. The spectrum has taken during this interval three separate and distinct though related forms. (*a*) A moderately strong continuous spectrum having superposed upon it a number of strong broad emission bands, maxima to red, accompanied by weak and faint absorption. (*b*) Continuous spectrum weaker than in (*a*) with strong emission bands shaded gradually to the red and sharply limited to the violet side by pairs of strong

moderately broad absorption lines. (*c*) Continuous spectrum very weak, emission bands strong and sharply limited at both sides; an absorption line to the violet side followed by weaker emission and about the same width of weak emission on the red side.

2. The measures of these spectra show six bands due to hydrogen, three to helium, two to calcium, two tentatively identified, six of unknown origin.

3. The measures of the sharp absorption lines of calcium, magnesium and iron indicate a mean velocity of recession of about 12 km. per second. It is probable that this velocity is not constant but varies over a range of about 15 km. per second.

There is little use in speculating about the physical cause of the peculiarities in this and other similar spectra. It seems most improbable that the widened emission and the largely displaced absorption lines are due to motion of the gases in the line of sight which would require velocities of the order of a thousand kilometres. There is, however, one phenomenon in accord with such an hypothesis, which is that the width and displacement are proportional to and vary with the wave length, a condition which gives equal velocity for all lines. When we consider that this outburst, collision, explosion, or whatever it may have been, has set free sufficient energy to increase the light given out by this body, probably of the order of our sun in mass, thousands of times in a few hours, it seems hopeless from any terrestrial experience to attempt to explain the cause of the characteristic spectrum and of the changes that occur in it. We must perforce be content to carefully observe all possible phenomena in the hope that the mystery may eventually be partially cleared up.

It gives me much pleasure to acknowledge the interest of Dr. King in this work and to express my thanks for permission to publish the results.

Later.--The spectrum seems to have reverted to the first type described above according to a plate obtained on April 10th.

DOMINION OBSERVATORY,
OTTAWA, CANADA.
April 4, 1912.

MEETINGS OF THE SOCIETY

Annual Meeting at Toronto

The General Annual Meeting of the Society was held in the Rooms, 198 College Street, Toronto, on January 16, 1912.

In the absence, through illness, of the President, the 1st Vice-President, Professor L. B. Stewart, occupied the chair.

Encouraging reports were presented regarding the work at the various Centres.

The following were elected officers of the Society for 1912:

Honorary President—Dr. W. F. King, C.M.G., LL.D., Ottawa.

President—Professor L. B. Stewart, Toronto.

First Vice-President—J. S. Plaskett, B.A., Ottawa.

Second Vice-President—A. D. Watson, M.D., Toronto.

Secretary—J. R. Collins, Toronto.

Treasurer—Chas. P. Sparling, Toronto.

Recorder—Lachlan Gilchrist, M.A., Toronto.

Librarian—Dr. W. M. Wunder, Toronto.

Curator—R. S. Duncan, Toronto.

Council—G. Parry Jenkins, F.R.A.S., Hamilton; Rev. I. J. Kavanagh, M.A., D. Sc., Montreal; Rev. Dr. Marsh, F.R.A.S., Peterborough; A. F. Miller, Toronto; Sir Joseph Pope, K.C.M.G., Ottawa; R. M. Stewart, M.A., Ottawa.

These with the Past Presidents and the presiding officer of each Centre constitute the General Council of the Society.

The General Annual Conversazione of the Society was held in the Physics Building of the University of Toronto, on the evening of January 23, 1912.

The retiring President, Professor A. T. DeLury, gave the Annual Address on "Theories of World Making," which appears in this issue (page 1).

After the address a splendid series of recent astronomical photographs, with short explanations, was shown by Professor C. A. Chant, and interesting optical experiments were performed under the direction of Mr. L. Gilchrist.

FINANCIAL STATEMENT
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

1911	RECEIPTS, 1911		
Jan. 1	Balance in Imperial Bank		2253.74
	Grant from University Library (for exchanges)		100.00
	Grant from Ontario Legislature		600.00
	Grant from Dominion Government		2000.00
	Grant from Corporation of Toronto City		100.00
	Fees from Members		828.48
	Interest on Deposits		62.50
			$5944.72

1911	DISBURSEMENTS, 1911.	
Dec. 31	Publication of JOURNAL and YEAR BOOK	1868.33
	Public Meetings	170.65
	Books for Library	65.90
	Exchanges on cheques	2.10
	Stationery and Postage Stamps	118.87
	Slides for Lanterns	4.51
	Salaries	374.50
	Rent of Rooms	200.00
	Grant to Peterboro Centre	125.00
	Grant to Hamilton Centre	125.00
	Grant to Ottawa Centre	125.00
	Grant to Guelph Centre	125.00
	Grant to Winnipeg Centre	120.00
	Printing—Sundry Accounts	19.95
	Int. on Reserve Fund and Bond trans.	17.95
	Cash in Imperial Bank	2481.84
		$5944.72

CASH ASSETS, 1911.

Balance in Imperial Bank	2481.84
Can. Permanent Mtge. Co's Bond dep. in Imp. Bank	872.40
Reserve Fund in Savings Branch Imp. Bank	56.60

Respectfully submitted,
CHAS. P. SPARLING,
General Treasurer.

Audited and found correct,
(Signed) A. D. WATSON,
ROBERT TYSON.
Toronto, January 4, 1912.

AT TORONTO.

February 6, 1912.— The meeting was held in the Chemical and Mining Building of the University of Toronto, President Stewart in the chair.

Mr. T. Roddy, of 15 Bloor St. West, Toronto, was elected a member of the Society.

The lecture of the evening was given by John A. Brashear, D.Sc., F. R. A. S., etc., of Allegheny, Pa., on "The Making of Giant Telescopes and What They Will Do." In the course of his remarks the lecturer referred to Mr. J. S. Plaskett, B.A., of the Dominion Observatory, Ottawa, in eulogistic terms. The exceedingly delicate work and great skill required in the making of the object glasses of large telescopes was graphically presented, and beautifully illustrated by lantern slides. The difficulty in making these glasses, so far as size is concerned, increases as the cube of the diameter; and in larger sizes it become a serious problem how and where to get the glass properly cast. At present Germany is doing most satisfactory work in this respect. A number of other very interesting points were presented by the lecturer, who concluded amid hearty applause, and was accorded a most cordial vote of thanks.

February 20.— The meeting was held in the Rooms of the Society at 198 College Street, Toronto. Professor A. T. DeLury occupied the chair, in the absence of the President.

Professor DeLury read the paper of the evening on "Astronomy as a Recreation," by Sir Joseph Pope. It was exceedingly interesting, and was listened to with close attention. A full account will, it is hoped, be published in the Society's JOURNAL.

March 5.— The meeting was held in the Rooms of the Society at 198 College Street, Toronto, at 8 p.m.; President Stewart in the chair.

Mr. Z. M. Collins gave an account of an observation of the moon on Sunday, March 3rd, there being a most remarkable halo with a false moon at each side.

The President, Professor Stewart, delivered the lecture of the evening on "Time, and Related Problems."

The lecturer then showed that for practical purposes it is best, with Newton, to regard time as something flowing uniformly, and to regard uniform motion as a fundamental conception. Thus any uniform motion, of which we have the best example in the earth's rotation, may be used in the measurement of time.

The lecturer pointed out the method of using the stars to get the length of a sidereal day, and showed how an observer could fit up an instrument to get the transit of a star across the meridian, by means of metal circles forming an armillary sphere. He described the method of using this simple apparatus in ascertaining the right ascension and declination of stars, also the sidereal time. It could also be used to get the apparent solar time. Then the reason for the variation of the true solar day was shown.

Professor Stewart next told how the unit of time was obtained, and outlined the motions of the true sun, the first fictitious sun, and the mean sun. The true sun was coincident with the fictitious sun at perigee and apogee, and the mean sun was coincident with the fictitious sun at the equinoxes.

A lantern slide was exhibited showing a diagram giving the positions of the true sun and the first fictitious sun, in the ecliptic, and the mean sun in the equator, for every tenth day of the year, which thus determined graphically the equation of time and its changes.

An explanation was also given of the variation in the time of rising and setting of the sun at the solstices, and of the difference in the length of time from sunrise till noon and from noon till sunset. L. G.

At Ottawa

December 21, 8 p.m.—The Annual Meeting of the R. A. S. C. at Ottawa for the year 1911, was held at the Dominion Observatory this evening, Mr. J. S. Plaskett presiding.

The minutes of the annual meeting for the year 1910 were read and approved, and the application for membership of Mr. A. Hawkins, D.L.S., of Listowel, Ontario was read.

A short report by the Secretary of the work of the Society for the year, showed its healthy condition in regard to growth in membership and activity in the carrying out of a good programme of lectures, and was adopted on motion of the Secretary, seconded by Mr. R. M. Stewart. The report of the Treasurer, which was adopted on motion of Mr. C. C. Smith, seconded by Mr. W. E. Harper also indicated the prosperity of the Society in a financial way.

The election of officers resulted as follows:—

President:—J. S. Plaskett.
Vice-President:—R. M. Stewart.
Secretary:—Carl Engler.
Treasurer:—C. C. Smith.
Councillors:—W. E. Harper, F. A. McDiarmid, R. E. DeLury.

Mr. Motherwell acted as scrutineer. In the course of the voting the question was raised as to whether Dr. King being an honorary member had a vote. The question was viewed in two ways (1) being an honorary member he should not vote (2) as he was a Fellow of the Society he was an active member and therefore entitled to a vote. The meeting decided that the second consideration overrides the first and Dr. King voted.

After the election a general discussion of matters pertaining to the welfare of the Society took place. Mr. Harper suggested that the Society commence collecting and classifying the lantern slides used by the lecturers. This brought on a discussion as to whether the local centre of the Society can hold property or not, which was decided in the negative. In view of this it was arranged that the slides should be left with the Observatory and Mr. Harper was asked by the Society to supervise the classification and cataloguing.

The meeting then adjourned.

PROGRAMME, JANUARY-MAY, 1912.

January 18th, 3 p.m.—"Meteorological Phenomena" (Illustrated).—Otto Klotz, LL.D.

February 8th, 8 p.m.—"The making of a Great Telescope" (Illustrated).—J. A. Brashear, Sc. D.

February 15th, 3 p.m.—1. "Notes from the Washington meeting of the A. and A. S. A."—W. F. King, C.M.G., and J. S. Plaskett, B.A.

2. "Some Surveying Experience."—J. J. McArthur, D.L.S., Thos. Fawcett, D.T.S., J. B. Craig, D.L.S.

February 29th, 8 p.m.—"The Heavens through a Field Glass" (Illustrated).—T. H. Parker, M.A.

March 14th, 3 p.m.—"Precise Levelling in Canada."—F. B. Reid, D.L.S.

March 28th, 8 p.m.—"Experiments on Currents of High Potential and High Frequency (Illustrated).—O. Higman, M.I.E.E.

April 4th 3 p.m.—"Review of Current Progress in Astronomy."—Members of the Observatory Staff.

April 25th, 8 p.m.—"The Planet Jupiter" (Illustrated).—Sir Joseph Pope, K.C.M.G.

May 9th, 3 p.m.—"The Solar Rotation"—R. E. DeLury, Ph.D.

January 18, 1912:—The first meeting of the spring term was held at the Observatory this afternoon, Mr. J. S. Plaskett presidins for the first part of the meeting, after which the chair was taken by Dr. King, Mr. Plaskett being called away on account of an engagement.

Mr. Albert Hawkins, D.L.S. of Listowel, Ontario, was elected a member of the Society.

Dr. Otto Klotz then gave an address on "Meteorological Phenomena." He first spoke of the units used by scientists in measuring the quantities they had to deal with. From the three fundamental units of the C. G. S. system, the centimeter, the gramme and the second he deduced definitions and formulæ for velocity, acceleration, momentum, force, work and heat. He then pointed out that formulæ reduce to identities when quantities involved are converted into dimensions and gave examples from formulæ for pendulum vibrations, the oscillation of a

magnet in a magnetic field and the change of velocity of light in passing from one medium to another. The importance of a system of units was explained inasmuch as such units not only measured quantities on the earth but throughout the universe. In connection with solar radiation he explained the meaning of a *caloric* and thus led up to the derivation of the temperature of the sun which is at least 6000° C.

Dr. Klotz then spoke of several phenomena often seen, but seldom observed. The first of these, the scintillation or twinkling of stars was explained. It is due to the lack of homogeneity in density in the atmosphere, the latter being permeated more or less by "Schlieren" or streaks 2 to 15 cm. in length. These produce differential refractions, and the greater the zenith distance of the star the greater the divergence, so that at zenith distances greater than 50° the original ray, as while light, no longer reaches the eye in its entirety, but only some of its constituent parts, giving rise thereby to color sensation and variability in brightness. This is most marked, naturally, near the horizon where the constituent rays of the original beam at the outer limits of our atmosphere, become most widely separated. Dr. Klotz showed a slide giving the divergence of the red and violet rays for different zenith distances.

Next he gave a lucid explanation of the rainbow, showing a model, giving the position of the observer, the sun and the rainbow, the latter being in the surface of a cone whose apex was the eye and axis through the sun, so that as the sun rose, the bow went down. He drew attention to the order of colors and the reason thereof. As a mnemonic word he gave IVOR (inside violet, outside red). In the halo produced by refraction in ice-crystals this order is inverted.

The optical illusion which makes the sun and moon appear larger on the horizon was clearly explained by means of diagrams.

Dr. Klotz finally gave an explanation of how weather forecasts are made. The main causes of the circulation of the atmosphere are the heat at the equator and the rotation of the earth.

These two causes produce trade winds. But other causes are at work rendering the dynamics of the air very complicated. However by means af the barometer, which gives the pressure of the air at any place, the temperature, and the direction of the wind, charts are made showing the isobars, and the state of the atmosphere every morning at 8 a.m. Eastern Standard Time. From these the weather man learns the prevailing conditions of the atmosphere. Examining the chart he sees the position of the "lows" or storm centres, and of the "highs," and from his experience he can make a pretty accurate estimate where they will be in the next 24 or 36 hours, and consequently of the weather to be expected. Were our telegraph lines all cut the daily chart could not be derived and we would have no "Probs.," at least no reliable ones.

Dr. Klotz closed his lecture with an emphatic denial that the moon had anything to do with the weather.

An interesting discussion followed in which Dr. King, Mr. Wm. Ogilvie and Mr. Herriot took part.

February 8, 8 p.m.:—The second meeting of the term was held in the Y. M. C. A. hall this evening, Mr. J. S. Plaskett presiding.

The lecture of the evening was given by Dr. J. A. Brashear, of Allegheny, Pa., the subject being, "The Making of a Great Telescope."

Dr. Brashear's lecture was of a popular nature but contained much of interest to professional astronomers. He first spoke of the possibility of amateurs making their own telescopes and recommended this to his audience as an interesting and instructive pastime. The main part of his talk was devoted to the making of large telescope lenses, and he told at considerable length how the glass for a large lens was obtained. At a comparatively recent date it was seriously stated by a certain historian that it would take 18,000 years to make a 6 inch glass: this could now be done in a week. The serious difficulty of the early glass makers was to prevent the cracking of the glass whilst cooling. It is still a difficult problem, as at a certain temperature (about 997° C, the

point at which all substances begin to glow when being heated), the greatest care had to be taken to prevent the glass being ruined. In making glass for large telescopes as much as three months was taken up in cooling the glass disc. Another important thing in making the glass is to have it free from strain, which is secured in part by melting the glass over again.

Having secured a large piece of glass a study is made of its structure and imperfections. The latter are cut out and the glass is melted again and brought to a more regular shape. The melting can be done only twice as the third melting devitrifies the glass and makes it worthless.

The lens-maker now fashions a prism from the same kind of glass and studies its properties, and calculates what curves will be required for the lens. Having done this, the glass is shaped, first by rough iron tools with crushed steel to act as an abrading material. This brings the lens quickly to its approximate shape. Then tools of plate glass are made and finer and finer abrading materials are used. Finally a tool made of aluminium faced with pitch and rouge for an abrader is used. The lens must be very carefully ground at its edges so as to be properly centred. The process of testing the lens is carried out first by means of a spherometer and then by means of a collimator and artificial star.

Dr. Brashear then showed a series of views to illustrate the making of lenses and also to show the work which they could do in the way of opening to our view the far regions of space.

At the close of the lecture, a vote of thanks, moved by Mr. A. H. McDougall, seconded by Prof. F. T. Shutt was heartily endorsed by the large audience, after which the meeting adjourned.

February 15, 3 p.m.—The third meeting of the spring term was held at the Dominion Observatory, Mr. J. S. Plaskett presiding.

Mr. E. E. Wilson, B. Sc., of the Topographical Surveys was elected a member of the Society.

The afternoon program consisting of

(1) Notes by Mr. J. S. Plaskett and Dr. King on the

Washington meeting of the Astronomical and Astrophysical Society of America.

(2) Some surveying experiences by Mr. J. J. McArthur, Mr. Thos. Fawcett and Mr. J. D. Craig.

Mr. Plaskett in his report of the meeting of the Astronomical and Astrophysical Society dealt chiefly with spectroscopic work. He referred to papers by J. A. Parkhurst on "Colors, Spectral Types and magnitudes of stars 17° from North Pole," and the relations between color, spectral type and magnitude.

J. G. Porter gave a paper on Star Charts which showed the superiority of the chart made from visual observations over that made from photographic plates.

A paper by J. C. Duncan, of Harvard University, was of note as it drew attention to the fact that the orbit of the spectroscopic binary β Scorpii as deduced from Allegheny and Flagstaff was similar in form but the velocity of the system as deduced by the two observatories was different.

A paper by Prof. H. N. Russell, of Princeton, explained the the variability of the light of some stars on the assumption of two eclipsing variables, and also threw new light on the evolution of of stars from nebulæ.

Dr. King confined his remarks to a short description of an instrument designed for the International Geodetic Station 30 miles northwest of Washington, for the purpose of determining variation in latitude. Dr. King showed how this instrument differed from the ordinary zenith telescope, and discussed its several points of superiority and also some of its weak points.

The experiences of surveyors proved to be very interesting and instructive. Mr. McArthur gave an account of his trip to the northwest in 1872, bringing out very clearly the changes in the country since that time. In the absence of Mr. Thos. Fawcett Mr. Wm. Ogilvie told some very amusing stories of camp life in the early days of the West. Mr. J. D. Craig gave an account of some thrilling adventures in the Yukon.

C. E.

AT HAMILTON

December 18, 1911.—At the regular meeting held this evening the President delivered an address entitled "An Invitation to a Reception at the Dominion Observatory to meet the Astronomical and Astrophysical Society of America."

The lecturer described the trip in its social aspect, first giving an idea of the feeling of good fellowship existing among the members gathered from all parts of this continent.

He then mentioned some of the papers given at the session and also referred to the great task, now approaching completion, of photographing the entire heavens undertaken by eighteen observatories.

Lastly he described the instruments and some of the work being done at the Dominion Observatory of which we Canadians have reason to be proud.

January 26, 1912.—A lecture entitled "The Spectroscope in Celestial Measurements" was this evening given by Professor W. H. Day, B.A., of the Agricultural College at Guelph.

He described the advance of spectroscopy from the time of Newton on, explaining the work of Wollaston, Fraunhofer, Stokes, Thomson, Kirchhoff and Bunsen.

The recognition in the sun's atmosphere of the various elements known on the earth was interestingly told.

Having described the Doppler principle, he pointed out a few of the resulting discoveries, among them demonstrations of the rotation of the sun and Jupiter, the determining of the nature of Saturn's rings and the radial velocity of the stars. Lastly the temperature of the sun was studied from observation of the point of maximum heating in the spectrum at different temperatures.

February 9.—A regular meeting of the Hamilton Centre was held this evening at which a lecture entitled "Suns and Systems of the Visible Universe," was delivered by Mr. W. B. Musson, of Toronto.

The lecturer described the various theories of the birth of suns and systems from the different kinds of nebulæ, to spectro-

scopic binaries, telescopic binaries, double stars and systems. He told of the various connections between the eccentricities of orbits and the periods of binaries, of the evidences of successive appearances of different gases in nebulæ and the conflicting theories of the creation and degradation of matter, by some thought to be taking place in those vast luminous clouds buried in the depths of space.

February 23.— Rev. Dr. Marsh, of Peterborough, gave a lecture this evening on the "Recent Investigations concerning the Planets, Especially Saturn."

The lecturer described the construction of the Solar System in general and then, beginning at Mercury, told of the latest facts ascertained about each planet.

Mercury being so near the sun is difficult to observe.

Venus is in much the same position. The controversy is still unsettled as to the rotation of Venus, whether it always turns one face to the sun or revolves on its axis in a time comparable to our day.

Mars may possibly be the abode of life, but recent investigations into the amount of water-vapor in its atmosphere throw much doubt on its habitability.

The Asteroids are too small to be seen in any but the larger telescopes. Eros, one of them, is of great importance on account of its near approach and hence its use as a means of measuring the sun's distance.

Jupiter probably has some light of its own but is so cloud encompassed that nothing can be seen but belts and marks continually changing. Reference was made to the great red spot now no longer visible, the rapid rotation of the planet and its attendant satellites.

Referring simply to Uranus and Neptune as too far off to admit of much being known of their surface the lecturer turned his attention to Saturn. The wonderful system of rings was described, the different theories concerning their composition and

formation were discussed, and the effects of the different positions they take up were illustrated and explained.

March 8.— A very interesting, instructive and poetical lecture was delivered before the Centre this evening by Mr. John A. Paterson, K.C., of Toronto. The title of the lecture being "The Apex of the Sun's Way." First the meaning of the term was explained and then the various movements of the earth were described.

The difficulties of the work were shown and the wonderful persistence and industry of the various astronomers commented upon.

The manner in which the opening up of the stars ahead and the closing together of those behind were observed, the eliminating of the effects of proper motions of the stars by the law of averages and the measuring of radial velocities all lead to the fixing of the apex on the border between Hercules and Lyra.

The lecturer very poetically described some of the wonders some future astronomers may be allowed to see. A close approach to the noted double double in Lyra, the wondrous cluster of 25,000 suns ever growing brighter as we approach Hercules, the blazing of Vega as one became nearer neighbors went to make up a lecture which will long be remembered by those who heard it.

T. H. W.

At Peterborough

January 26.—There was a good attendance in the Assembly Hall of the Collegiate Institute to hear Professor C. A. Chant, of the University of Toronto, lecture on the subject "The Planet Mars."

Dr. Chant remarked that he was glad to hear the astronomical work in Peterborough was flourishing. He had, he said, a class in elementary astronomy composed of about 170 students and the practical observations, as well as lantern slides and photographs, aroused in them much interest.

The planet Mars was of much interest in astronomy, because of its relation to the discovery of the law of gravitation. The planets travel around the sun in elliptical paths, and Mars was used by Newton in demonstrating that this motion was due to the law of gravitation.

Mars is interesting to the astronomers and all thinking people, who wonder and attempt to discover if it is similar to the earth, and whether or not it is inhabited.

Mars is in a good position for observation every two years, because it approaches near to the earth every second year on the same side of the sun as the earth. This is due to the fact that while the earth's passage round the sun takes one year, Mars completes its orbit in a little less than two years. This year the best time for observation was in November. Important observations were made in 1877, by the 26-inch telescope at Washington — then the largest one in the world — when the two satellites of Mars was discovered. Dr. Chant explained the existence of certain markings on Mars, which enables scientists to calculate the time that planet requires to make a complete revolution. Mars rotates on its axis in a period of time a little over 24 hours.

The lecturer went on to discuss the surface markings of the planet, and finally treated the subject from the standpoint of whether or not Mars was inhabited. He mentioned in this connection the perfectly straight markings on Mars, the so called "canals." Some observers have found the canals, others report that they can find no indication of their existence. The question of the existence of these geometrical markings was warmly debated in some quarters. Lowell, a well-known American astronomer, claims that these markings are caused by the vegetation springing up along the banks of real artificial canals. This, of course, argues for the existence of beings on Mars.

The lecture was illustrated by many lantern slides, which added interest to the lecture.

February 13.— On this evening a regular meeting was held in the Collegiate Institute, the President, Mr. H. O. Fiske, in the chair.

In a lecture entitled "Keys by which the Heavens are Unlocked," Dr. Marsh explained the process of the manufacture of the optical, mechanical and photographic parts of various astronomical instruments in use to-day.

D. B. M.

At Regina

February 2, 1912.—A very able and interesting lecture on "Planetary Atmospheres" was delivered to the members of the Society and their friends by Professor G. H. Ling, M.A., Ph.D., of the University of Saskatchewan. Mr. Hector Lang, B.A., the President of the Centre, acted as chairman, and there was a goodly number of the members present in spite of the very cold weather during the evening.

In the course of his address the lecturer outlined the molecular theory of matter and gradually introduced the discussion of the question, Can a molecule of matter leave the earth? If so will the earth ever lose its gaseous covering? The theories of the two great schools of thought on this question, the one advanced by Dr. Johnstone Stoney and Sir William Ramsay and the other by Drs. Cooke, Jean, Bryant and others, were then carefully presented by the lecturer.

Dr. Johnstone Stoney advocates that certain of the lighter gases, such as helium, do leave the earth while the heavier gases, such as oxygen and carbon dioxide do not. The dynamical question as to what would be the critical velocities of the gases for the various planets was then introduced and very interesting results as determined by Dr. Stoney in his investigation, were discussed.

Dr. Ling then pointed out that according to Dr. Stoney's theories, the moon could have no atmosphere, that Mercury, Venus and Mars would only have the heavier gases present, that Saturn, Uranus and Neptune would have all the gases excepting probably the lighter ones, as is the case with the earth, but that Jupiter would in all probability have all the known gases present in its atmosphere.

The lecture was followed by a very keen discussion which evidenced the very close attention and active interest with which the audience followed the lecturer. To all the subject was full of suggestion and food for contemplation ; not the least prominent was the idea of careful thought, vigorous enquiry and painstaking research on the part of the astronomers in their endeavors to penetrate the mysteries of our wonderful universe.

At the close of the address Mr. Norman MacMurchy moved a vote of thanks to Dr. Ling for coming to the city and addressing the Centre. We look forward with pleasure to a second visit from Dr. G. H. Ling.

A. J. P.

NOTES FROM THE DOMINION OBSERVATORY

MAGNETIC OBSERVATIONS

During the season of 1911, fifty-eight stations between Winnipeg and the Rocky Mountains were occupied, besides Ottawa and the base or reference station at Agincourt, in continuation of the systematic magnetic survey of Canada, undertaken by the Observatory.

The instruments used were the same as those of the preceding three years: a Tesdorpf magnetometer, No. 1977; a Kew Dip Circle, No. 145; and a Troughton and Simm's transit.

Almost without exception were eastern and western elongations observed at each station and their mean adopted for the declination of that day. Beside these elongation observations, the magnetic declination was observed too at other times and hours for the determination of the diurnal variation curve. The azimuth was obtained from observation on the sun both forenoon and afternoon.

Stations within the area covered, that had been occupied in previous years, were again occupied, and in every case either at the identical point or within ten feet of it, so that data were obtained for the secular variation or Annual Change, as shown by the second subjoined table.

As in former years, comparisons were made with the standard instruments at Agincourt before going to the field, as well as after return therefrom.

All the observations were made by Mr. C. A. French, of the Observatory staff.

MAGNETIC RESULTS FOR 1911

Station	Latitude	Longitude	Date	Declination	Dip.	Hor. Int.	Total Int.
	° ′	° ′		° ′	° ′	C.G.S.	C.G.S.
Ottawa	45 23·6	75 43·0	Apr. 21 - 28	13 7·1 W	75 39·9	·15097	·60975
Agincourt	43 47·0	79 16·0	" 6	8 5·5 W	74 39·6	·16209	·61270
Mortlach	50 27·2	106 04·0	May 10, 11	20 30·1 E	77 01·3	·14121	·62877
Chaplin	50 28·0	106 39·5	" 13, 14	21 08·1 E	76 39·6	·14455	·62649
Herbert	50 25·6	107 14·5	" 17, 18	21 58·3 E	76 30·6	·14630	·62716
Swift Current	50 16·3	107 48·4	" 20, 21	21 15·0 E	76 16·4	·14790	·62328
Gull Lake	50 06·4	108 29·0	" 23, 24	21 32·3 E	76 01·8	·15116	·62614
Crane Lake	50 01·2	109 04·8	" 26, 27	22 24·2 E	75 33·1	·15508	·62154
Maple Creek	49 54·6	109 30·0	" 29, 30	22 23·6 E	75 27·1	·15558	·61936
Walsh	49 57·1	110 02·4	" 31 June 1	22 00·3 E	75 29·3	·15486	·61800
Medicine Hat	50 02·6	110 40·5	June 2	21 58·3 E	75 30·0	·15521	·61990
Suffield	50 13·2	111 09·5	" 6	24 03·0 E	75 04·6	·15936	·61900
Tilley	50 27·2	111 38·8	" 8	22 19·4 E	75 26·8	·15451	·61480
Southesk	50 39·6	112 08·4	" 10, 12	23 23·6 E	75 18·7	·15639	·61677
Crowfoot	50 49·2	112 39·0	" 13	23 38·9 E	75 26·4	·15510	·61695
Gleichen	50 52·2	113 03·3	" 14, 15	24 27·1 E	75 28·1	·15519	·61840
Cheadle	51 01·8	113 32·7	" 16, 17	25 06·8 E	75 24·2	·15549	·61698
Calgary	51 04·8	114 04·2	" 20, 21	25 20·3 E	75 15·1	·15649	·61472
Morley	51 07·3	114 51·1	" 23	24 46·0 E	75 06·3	·15806	·61489
Banff	51 10·7	115 35·5	" 26, 27	26 12·9 E	74 56·2	·15914	·61234
Cro's Nest	51 25·9	114 01·1	" 28, 29	25 05·4 E	75 32·9	·15318	·61379
Olds	51 47·7	114 07·4	" 30 July 3	25 20·1 E	75 44·8	·15167	·61603
Red Deer	52 15·8	113 48·0	July 4, 5	25 31·8 E	76 15·8	·14698	·61897
Lacombe	52 27·6	113 45·2	" 6, 7	26 06·3 E	76 26·7	·14466	·61720
Wetaskiwin	52 58·2	113 21·3	" 8	26 19·7 E	76 51·2	·14092	·61957
Leduc	53 15·9	113 33·8	" 10, 11	26 38·2 E	77 01·9	·13972	·62260
Edmonton	53 32·1	113 29·2	" 13	27 23·3 E	77 20·4	·13654	·62299
Bruderheim	53 48·6	112 55·3	" 14, 15	26 58·0 E	77 36·6	·13325	·62102
Hilliard	53 38·8	112 29·4	" 18	26 44·0 E	77 37·5	·13333	·62213
Vegreville	53 29·0	112 01·6	" 19 - 21	27 17·5 E	77 40·0	·13315	·62336
Innisfree	53 22·8	111 31·0	" 21, 22	26 15·2 E	77 37·4	·13359	·62326
Vermilion	53 21·0	110 52·2	" 25, 26	25 53·2 E	77 48·0	·13190	·62415
Lloydminster	53 17·4	110 00·4	" 26, 27	25 30·6 E	78 03·5	·12918	·62431
Lashburn	53 07·3	109 37·0	" 29, 30	24 43·9 E	78 18·3	·12714	·62722
Paynton	53 01·6	108 55·4	Aug. 1	25 17·7 E	78 03·6	·12947	·62580
Battleford	52 43·6	108 17·9	" 4, 5	23 12·9 E	77 41·4	·13336	·62551
Ruddell	52 36·4	107 51·3	" 7, 8	24 39·5 E	77 47·5	·13314	·62960
Borden	52 24·2	107 14·2	" 9, 10	23 58·1 E	77 45·6	·13364	·63036
Warman	52 19·2	106 33·7	" 11, 12	24 16·3 E	77 52·7	·13187	·62798
Rosthern	52 39·6	106 20·5	" 15, 16	24 55·0 E	78 13·9	·12980	·63640
Macdowall	53 01·6	106 00·7	" 17, 18	25 47·8 E	78 57·8	·12228	·63875
Prince Albert	53 11·7	105 46·6	" 19	23 24·6 E	79 12·6	·11829	·63186
Birch Hills	52 53·1	105 25·9	" 22	20 55·0 E	79 08·1	·11970	·63504
Kinistino	52 57·5	105 01·2	" 25	20 16·5 E	79 03·3	·11929	·62827
Melfort	52 51·5	104 37·4	" 26, 28	21 03·9 E	79 00·5	·12030	·63095
Tisdale	52 51·0	104 02·5	" 29	20 00·7 E	78 54·5	·12206	·63447
Prairie River	52 52·3	102 59·1	" 30	21 52·4 E	79 18·9	·11760	·63475
Hudson Bay Jct.	52 51·9	102 23·7	" 31 Sep. 1	19 00·4 E	79 21·6	·11654	·63119
Barrows	52 54·0	101 28·0	Sept. 2, 4	18 11·0 E	79 37·6	·11413	·63383
Mafeking	52 41·2	101 07·0	" 5	18 26·5 E	79 38·5	·11464	·63752
Swan River	52 06·8	101 16·1	" 6, 7	18 42·8 E	79 05·4	·12040	·63614
Cowan	52 02·6	100 39·1	" 7, 8	20 40·5 E	78 52·0	·12334	·63876
Ethelbert	51 31·7	100 24·1	" 11	15 47·2 E	79 01·1	·12143	·63649
Dauphin	51 09·0	100 03·9	" 12, 13	15 25·5 E	78 24·4	·12828	·63831
Laurier	50 53·6	99 33·1	" 14, 15	15 08·3 E	78 18·4	·12813	·63218
Glenella	50 33·8	99 11·8	" 16	14 25·4 E	78 11·8	·12985	·63479
Gladstone	50 13·3	98 57·0	" 18, 19	14 15·4 E	78 02·2	·13097	·63182
Portage la Prairie	49 58·5	98 17·9	" 22, 23	9 23·7 E	78 28·9	·12777	·63987
Elie	49 54·0	97 43·5	" 25, 26	13 12·7 E	78 01·3	·13062	·62936
Winnipeg	49 51·9	97 07·9	" 27, 28	13 51·9 E	78 12·8	·12988	·63583
Agincourt	43 47·0	79 16·0	Oct.	6 10·6 W	74 39·7	·16188	·61197
Ottawa	45 23·6	75 43·0	" 19 - 24	13 00·4 W	75 40·8	·15066	·60913

Station	Date	Obs.	Dec.	Date	Obs.	Dec.	Aver. Annual Change	Dip.	Aver. Annual Change	Hor. Int.		Aver. Annual Change
										C.G.S.	C.G.S.	
Ottawa	Oct. 1906	C.I.	12 44·4 W	Oct. 1911	D.O.	13 09·4 W	− 5·0	75 39·1	75 40·8	0·3	·15222	·15066	− 31
Agincourt	Sept. 1906	M.S.	5 47·3 W	Sept. 1911	M.S.	6 13·9 W	− 5·3	74 35·0	74 38·8	0·6	·16388	·16196	− 38
Winnipeg	" 1906	C.I.	13 59·0 E	" 1911	D.O.	13 51·9 E	− 1·4	78 07·4	78 12·8	1·1	·13163	·12988	− 35
Portage la Prairie	Aug. 1910	D.O.	9 26·9 E	" 1911	D.O.	9 23·7 E	− 2·8	78 29·0	78 28·9	− 0·1	·12794	·12777	− 17
Swift Current	June 1907	M.S.	21 00·1 E	May 1911	D.O.	21 15·0 E	3·8	76 14·0	76 16·4	0·6	·14879	·14790	− 23
Medicine Hat	" 1907	M.S.	21 56·5 E	June 1911	D.O.	21 58·3 E	0·5	75 30·0	75 30·0	− 0·1	·15620	·15521	− 25
Calgary	" 1907	M.S.	24 58·7 E	" 1911	D.O.	25 20·3 E	5·4	75 18·0	75 15·1	− 0·7	·15693	·15649	− 11
Banff	" 1907	C.I.	25 59·3 E	" 1911	D.O.	26 12·9 E	3·4	74 56·3	74 56·2	0·0	·15930	·15914	− 04
Edmonton	" 1907	M.S.	27 08·9 E	July 1911	D.O.	27 23·3 E	3·5	77 20·7	77 20·4	− 0·1	·13662	·13654	− 02
Battleford	" 1907	M.S.		Aug. 1911	D.O.	23 12·9 E		77 42·4	77 41·4	− 0·2	·13434	·13330	− 23

Note:—C. I.—Carnegie Institution. M. S.—Meteorological Service. D. O.—Dominion Astronomical Observatory.

The M. S. observations for declination, with the exception of Agincourt, are the means of the observed declinations corrected for diurnal variation. The corrections have been obtained from the diurnal variation curve constructed from the mean of all the observations taken at various times of the day at the stations occupied last year between Chapleau and Moose Jaw, which was the best available data for the purpose. The values of the elements for Agincourt 1906 were taken from the *Meteorological Service Report* 1906, and those for 1911 from the JOURNAL OF ROYAL ASTRONOMICAL SOCIETY OF CANADA, 1911.

A "+" sign under "Average Annual Change" for declination indicates that eastern declination is increasing and western declination decreasing, while a "−" sign means the reverse.

From comparisons made with the Standard Magnetometer at Agincourt and Tesdorpf No. 1977 for Horizontal Intensity it was found that No. 1977 required a correction of − ·0012811 in 1910, and in 1911 the correction was − ·0025911. This large difference is, for the most part, apparently due to a reduction in the value of H owing to a re-determination of the constants of the Agincourt Magnetometer, Elliott No. 98, See *Terrestrial Magnetism*, June, 1911, page 79. The correction for 1911 was applied to the observed value of H at Portage la Prairie in 1910.

DOMINION OBSERVATORY,
OTTAWA, CANADA,
March 6, 1912.

OTTO KLOTZ.

NOTES FROM THE METEOROLOGICAL SERVICE

Earthquake Records by the Milne Seismograph

TORONTO

R. F. Stupart, Director.

P.T. = Preliminary Tremors. L.W. = Large Waves. Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

No.	Date 1911-1912	P.T Comm.	L.W. Comm.	Max.	End.	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm.	h m	
1062	Dec. 2	4 3·3		4 5·3	4 48·0	0·1	0 44·7	
1063	" 4	15 4·1	15 6·9	15 8·1 12·6	15 26·6	0·3	0 22·5	No defined Max.
1064	" 6	23 20·9	23 28·9	23 36·8	0 28·5	0·3	1 07·6	A. T. going on.
1065	" 16	19 21·1	V_2 19 25·5 V_3 28·8	19 41·0	22 35·9	10·1	3 15·0	Mexico
1066	" 20	6 2·8	6 9·9 6 25·0	6 39·3	8 2·6	0·8	1 59·8	Long duration of [L.W.
1067	" 22	13 7·0	V_2 13 9·6 V_3 13 12·3	13 17·8	14 16·0	0·8	1 9·0	
1068	" 23	No P.T's	20 3·4	20 3·7	20 8·9	0·2	0 5·5	Began suddenly
1069	" 23	21 19·4	21 23·2	21 25·9	22 39·3	0·7	1 19·9	Eq. reported from [Nicaragua
1070	" 29	15 49·8? 15 57·4	16 4·9	16 21·4 16 24·0	17 44·5	0·2	1 54·7	Begin. doubtful
1071	" 31	6 55·8			7 14·0	0·05	0 18·2	
	1912							
1072	Jan. 4	14 37·0			14 42·5	0·1	0 5·5	
1073	" 4	14 49·3			14 53·3	0·05	0 4·0	
1074	" 4	15 57·7	V_2 16 6·5 V_3 16 12·7	16 29·8 B 16 19·7	18 1·8	1·0	2 4·1	Well defined
1075	" 16	11 18·6		11 20·7	11 28·2?	0·1	0 9·6	A.T. present
1076	" 24	16 59·6	V_2 17 6·5 V_3 17 9·7	17 11·9	17 35·4	0·2	0 35·8	Ionian Islands
1077	" 25	2 4·2	2 8·3	2 10·5	2 21·7?	0·2	0 17·5	
1078	" 31	11 44·0? 11 49·5			12 12·9?	0·1		A.T. present
1079	" 31	20 21·6 20 25·8	20 28·9 20 33·6	20 37·9	22 18·8	5·9	1 57·2	Heavy eq. shocks s. w. Alaska, first and most severe at 11h 12m; three lighter ones follow, at intervals of an hour.

Period 14·7 seconds. 1 mm. = 0″·64.

VICTORIA, B. C.

E. B. REED, SUPERINTENDENT.

No.	Date 1911-1912		P.T. Comm.		L.W. Comm.		Max.		End		Max. Amp.	Durat.		Remarks
			h	m	h	m	h	m	h	m	mm.	h	m	
1074	Dec.	2	4	1·0	4	1·3	4	2·5	4	14·2	1·2	0	13·2	
1075	"	4	15	3·9	15	5·0	15	6·6	15	20·3	0·4	0	16·4	
1076	"	6	23	24·0					23	35·0	0·1	0	11·0	
1077	"	6	23	45·5	23	51·1	23	54·2	0	31·9	0·4	0	46·4	
1078	"	16	19	21·7	V_2 19	25·8	19	36·1	21	59·1	over 25	2	57·4	Mexico
					V_1 19	27·9								
1079	"	17	3	15·5	3	18·5	3	19·7	3	21·7	0·2	0	6·2	
1080	"	19	6	3·7					6	12·7	0·2	0	9·0	(seismic) Doubtful as to being
1081	"	20	5	51·1? 58·3	6	2·8	6	4·3			0·3			First measurement (doubtful
1082	"	20			6	13·5	6	20·5	7	39·3	0·5	1	48·2	In. of move'nt at 6 40.2
1083	"	22	13	7·6	13	16·8	13	18·3	14	4·6	1·2	0	57·0	L. Ws. came in abruptly
1084	"	23	20	1.0					20	7·0	0·1	0	6·0	
1085	"	23	21	20·8			21	49·8						
			V_2 21	23·8	21	35·1	21	48·2	22	50·3	0·3	1	29·5	
1086	"	29	15	43·3	15	53·6	15	59·6	16	47·9	0·2	1	04·6	Marked thickenings
	1912													
1087	Jan.	4	14	37·4					14	41·0	0·05	0	3·6	
1088	"	4	14	50·2					14	57·1	0·10	0	7·1	
1089	"	4	15	53·5	15	59·3	16	18·0	18	7·0	1·2	2	13·5	Well defined.
1090	"	16	11	28·0			11	32·7	11	36·0	0·1	0	8·0	
1091	"	24	17	11·4?	17	18·8	17	22·1	17	38·4	0·1	0	27·0	Beginning doubtful
1092	"	25	2	1·8					2	11·8	0·05	0	10·0	(Ionian Islands
1093	"	31	11	49·2			11	51·7	12	2·5	0·2	0	13·3	
1094	"	31	Attend. inst		20	23·2	20	27·4	21	58·4	4·1			S. W. Alaska

Period 15 seconds. 1 mm. = 0″·76

J. V.

MAGNETIC OBSERVATIONS

The magnetic curves for the months of December 1911 and January 1912 were remarkably free from disturbances. The only one of note occurred on the 10th and 11th of December. In declination the first large wave began quite abruptly at 22^h 18^m of the 10th with a decrease in westerly declination from 6° 10′·6 to 5° 23′·8 in a period of 21 minutes, followed by a return to 6° 10′·0 in the next 49 minutes. There then occurred a succession of smaller waves reaching a maximum westerly declination of 6° 33′·3 at 7^h 55^m of the 11th, after which the curve gradually became normal again. The Horizontal Force curve departed from normal about 19^h of the 10th, the Force decreasing gradually until reaching its minimum value of 0·15986 dynes at 3^h 14^m of the 11th. There then occurred several waves of an amplitude of about 80γ each, with the force gradually increasing to maximum of 0·16227 dynes at 16^h 23^m of the 11th and then as in Declination returning to normal values at about 20^h of the 11th.

Declination

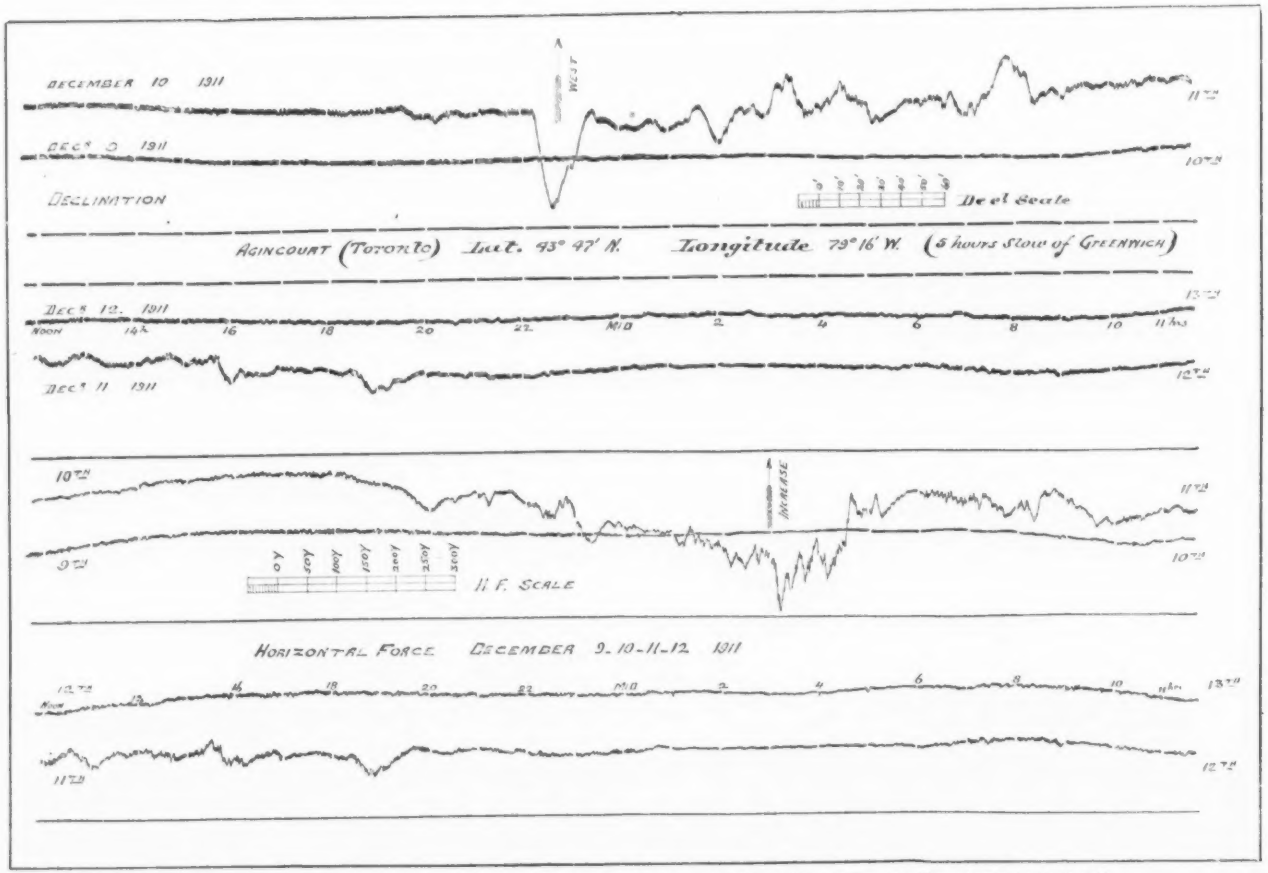
Month	Mean of Month	Max.	Date	Min.	Date	Monthly Range	Amplitudes—Mean Daily	
							From hourly readings	From Means of Extremes
1911-12	° ′	° ′		° ′		° ′	° ′	° ′
Dec.	6 11·8	6 33·3	11	5 23·8	10	1 9·5	0 6·1	0 11·2
Jan.	6 12·3	6 33·6	13	6 6·6	13	0 27·0	0 4·3	0 7·5

Horizontal Force—C.G.S. Units

Dec.	·16188	·16227	10	·15986	11	·00241	·00020	·00044
Jan.	·16194	·16218	17	·16136	13	·00082	·00011	·00026

Inclination

Month	Mean
	° ′
December	74 40·0
January	74 38·8



Record of Magnetic Declination (upper half of cut), and Horizontal Force (lower half) at Agincourt (Toronto), December 9, 10, 11, 12, 1911.

Summary Report of the Weather in Canada

December, 1911.

Temperature — Over the greater part of British Columbia the mean temperature for December was below average, with a maximum negative departure of 6° in the Kootenay Valley. In the extreme southwest, however, temperatures were about normal. In the southern and western portions of Alberta the average for the month ranged from normal to 6° below, while in the northeastern districts the normal was closely approached. In practically all parts of Saskatchewan and Manitoba temperatures for the month were above average, ranging from about normal in southwestern Saskatchewan to 4° and 5° above normal in southeastern Saskatchewan and eastern Manitoba. In Ontario and Quebec the mean was from 6° to 11° above average, the greatest departure being in the Ottawa Valley and northwestern Quebec. In the Maritime Provinces temperatures were also above normal, ranging from 5° to 7° above in New Brunswick, and from 1° to 5° above in Nova Scotia and Prince Edward Island.

Precipitation — Precipitation for the month was below normal in all parts of British Columbia except the central districts, where there was an excess. Throughout the Prairie Provinces there was likewise a general deficiency, it being especially marked in Alberta. In New Ontario, in the counties bordering on Lakes Erie and Ontario and in the Ottawa Valley precipitation was in excess of the average, but elsewhere in Ontario there was a deficiency. Throughout the province of Quebec the normal for the month was exceeded, as was also the case in northern New Brunswick. In the southern portions of the latter province, however, the normal was not reached, and in Nova Scotia and Prince Edward Island there was a considerable deficiency. Snow fell in most portions of the Dominion during the month.

JANUARY, 1912.

Temperature—A prolonged cold period lasting practically the whole month marked the weather throughout Canada, and the resultant mean was much below average in most districts, the month being in many places the coldest on record for years. In extreme southwestern British Columbia the normal was closely approached, but in the interior of the province temperatures for the month were from 6° to 8° below average. In Alberta temperatures ranged from normal to 4° below normal, while in Saskatchewan and Manitoba there was a negative departure of from 6° to 12°. In the Lake Superior districts of Ontario the monthly mean was from 14° to 15° below average, and in the southern and eastern portions of the province there was a negative departure of from 9° to 11°. Temperatures in the lower St. Lawrence Valley were from 6° to 8° below normal, while in the Maritime Provinces the negative departure was from 4° to 6°.

Precipitation—In British Columbia the precipitation for the month exceeded the normal in the central districts, but elsewhere in the province there was a general deficiency. In Alberta precipitation was considerably in excess of the average. In Saskatchewan and Manitoba, however, only from one-third to one-half of the normal amount fell. In the Georgian Bay districts of Ontario precipitation was considerably above the average, but in the southern peninsula the normal was generally approached. Precipitation for the month fell short of the average in southwestern Quebec; throughout the remainder of the province, however, there was a considerable excess. Throughout the greater part of New Brunswick there was a positive departure, as was also the case in eastern Nova Scotia. In the western part of the latter province, however, and also in Prince Edward Island, there was a considerable deficiency.

Temperatures for December 1911, and January, 1912

Station	December		January	
	Highest	Lowest	Highest	Lowest
Yukon				
Dawson	44	-60	20	-62
British Columbia				
Atlin	40	18	20	-34
Agassiz	53	10	53	12
Barkerville	40	20	40	-28
Kamloops	56	- 4	54	-14
New Westminster	51	20	51	14
Prince Rupert	54	12	54	8
Vancouver	52	26	50	16
Victoria	50	30	52	23
Western Provinces				
Battleford	38	-32	36	-46
Broadview				
Calgary	50	-30	48	-30
Carman				
Edmonton	47	-32	48	-46
Medicine Hat	45	-30	43	-47
Minnedosa	36	-38	26	-45
Moose Jaw	48	-37	38	-44
Oakbank	35	-30	24	-44
Portage la Prairie	38	-31	21	-43
Prince Albert	34	-44	34	-52
Qu'Appelle	44	-32	36	-47
Regina	40	-31	35	-47
Swift Current	42	-32	38	-34
Winnipeg	38	-32	25	-41
Ontario				
Agincourt	54	3	37	12
Aurora	54	2	36	-23
Bancroft	50	-10	35	-45
Barrie	54	0		
Beatrice	51	- 3	34	-35
Birnam	57	12	39	-20
Bloomfield	55	5	39	20
Brantford	56	10	39	-17
Bruce Mines	46	0	30	36
Chatham	55	10	37	-14
Clinton	55	8	38	-21
Cottam	54	10	42	-17
Gravenhurst	50	1	35	-45
Guelph	55	8	38	16
Haliburton	48	-10	35	-46
Hamilton	58	2	33	- 9
Huntsville	47	- 4	34	-42
Kenora	32	30	18	-45
Kanmount	46	-13	34	47
Kingston	53	5	39	20
Lakefield	54	4	37	-21
London	56	4	38	-24
Lucknow	59	7	34	-26
Madoc	53	6	37	-32
Midland				
North Gower				
Otonabee				
Ottawa	52	- 2	36	-27
Owen Sound			38	-20
Paris	50	10	37	19
Parry Sound	50	3	33	-34
Peterboro'	52	1	37	-29
Port Arthur	39	-16	20	-36
Port Burwell	48	6	35	-22
Port Dover	54	7	35	21
Port Stanley	49	8	35	23
Ronville	50	- 2	32	51
Sarnia	52	10	37	-26
Southampton	56	6	34	-17
Stonecl ffe	48	-14	24	-40
Stony Creek	63	11	33	12
Stratford	54	7	37	-24
Toronto	55	9	38	-12
Uxbridge	53	- 2	36	-26
Wallaceburg	57	11	36	-16
Welland	58	9	40	-14
White River	42	-30	26	-58
Quebec				
Brome	57	-10	38	34
Father Point	46	- 1	33	-21
Montreal	53	1	35	10
Quebec	46	- 8	34	23
Sherbrooke	57	- 7	40	36
Maritime Provinces				
Charlottetown	51	7	43	-14
Chatham	52	7	42	-22
Dalhousie	47	2	20	-22
Fredericton	56	- 2	46	-32
Halifax	57	11	48	- 7
Moncton	56	0	50	-19
St. John	52	3	40	-13
St. Stephen	59	- 1	47	-31
Sussex	55	0	51	-29
Sydney	56	12	48	13
Yarmouth	53	16	47	2

ASTRONOMICAL NOTES

SATURN'S RING. — In explanation of a telegram sent to the President of the Royal Astronomical Society, London, on January 12th last, Professor Todd, of Amhurst College, New York, after giving in brief the history of the discovery of the ring-system and Keeler's observational corroboration of Clerk-Maxwell's deduction that the rings are really a cloud of separate particles, goes on to say :—

"It only remained to visualize the separate particles of which the ring is composed. There are many telescopes powerful enough to make this observation possible, and the highly unfavorable conditions of our lower atmosphere are alone reponsible for failure hitherto to resolve the ring into its component satellites."

Professor Todd further states that for many years he had tried to make this observation, but did not succeed until October 28 and 29 of last year, when

"Near the extremities of the inner bright ring there was a lenticular shading, as drawn by Proctor and less pronouncedly by Barnard, and it was in this especial region that, in moments of the best vision, a certain sparkling flocculence was more or less steadily glimpsed ; scintillant much as fine snow-flakes sun-illumined at the close of a storm. There was no longer in the writer's [Professor Todd's] mind any doubt that the separate components of the ring had been seen.—*Observatory*, No 446.

PREVENTING DEW-DEPOSIT ON GLASS SURFACES. — In *Monthly Notices*, R. A. S., No. 2, Vol. LXXII., Mr. J. Franklin-

Adams describes, with illustrations, a chemical method of preventing dew-deposit on glass surfaces with especial reference to telescope lenses and photographic plates.

Double Stars.— In *The Observatory*, No. 445, a pamphlet by Dr. Fr. Nolke is taken notice of, which endeavors to subject Dr. See and Professor Russell's theories in respect to the evolution of double stars to a rigid mathematical examination.

See and Russell have endeavored to prove that double stars, both visual and spectroscopic, owe their origin to the disruption of rotating nebulæ in a state of hydrodynamic equilibrium and that the nebula in process of contraction passes through a series of possible stable forms up to the pear-shape figure of Poincaré.

The conclusions Nölke arrives at are that the ratio of the masses of two stars originating from the disruption of a homogeneous rotating nebula does not exceed 3 to 1 and that the orbital eccentricity is too small and the tidal friction is inadequate to increase the eccentricity usually found in the orbits of most double stars; and that close double star systems only, could originate from a disruption of a rotating nebula as supposed by See and Russell.

Nova Geminorum No. 2.— The history of the new star, Nova Geminorum, No. 2, is given below. Results obtained at Harvard are indicated by the letter (H).

Sunday, March 10. Nova not visible on a plate showing stars of magnitude 11·5. (H).

Monday, March 11. Nova well seen. Mag. 5. (H).

Tuesday, March 12. Nova discovered by Enebo, at Dombaas, Norway. Mag. 4.

Wednesday, March 13. Cablegram received at Harvard and distributed throughout America. In the evening, Yerkes and (H) find spectrum of Class F5, unlike other Novæ. Hydrogen lines strong and dark. University of Michigan finds hydrogen lines bright and recession 5 km. from dark lines. Mag. 3·8. (H).

Thursday, March 14. Yerkes and (H) find marked change

in spectrum, hydrogen lines bright on edge of great wave length, like other novæ. Mag. 3·5. (H).

Friday, March 15. Photographs through thick clouds show nova faint mag. 5. Hydrogen lines very bright. (H).

Saturday, March 16. Mag. 6, spectrum like normal nova spectrum. Nebula lines first seen. A star magnitude 14 in place of Nova on several early plates. — EDWARD C. PICKERING, Harvard College Observatory *Bulletin*, No. 489.

SPECTROSCOPE METHODS. — Professor A. A. Michelson, American Association for the Advancement of Science; Presidential Address, December 27, 1911.

To return to our comparison of the telescope and the spectroscope; while the progress of investigation of the stellar universe will be ever furthered by increased size and resolving power of the telescope, this is very seriously hampered by the turbulence of the many miles of atmosphere through which the observations must be made. But there is no corresponding limit to the effective power of spectroscopes and the solution of the corresponding problems of the sub-atomic structures and motions of this ultra-microscopic universe may be confidently awaited in the near future.

The message we receive from the depth of the stellar firmament or from the electric arcs of our laboratories, come they in a millionth of a second or in hundreds of light years, are faithful records of events of profound significance to the race. They come to us in cipher — in a language we are only beginning to understand.

Our present duty is to make it possible to receive and to record such messages. When the time comes for a Kepler and a Newton to translate them we may expect marvels which will require the utmost powers of our intellect to grasp.

ASTRONOMICAL SOCIETY OF FRANCE. — From a summary of the list of members of the Société Astronomique de France, it appears that, beginning with ninety members in 1887, the Society now has a membership of 2,964. Corresponding to this increase

in membership, the Bulletin of the Society, now published under the title *L'Astronomie*, has grown from an annual volume of 128 pages in 1887, to one of 658 pages in 1911. It is doubtful whether any other astronomical society, professional or amateur, can show a like degree of prosperity.— *Publications Astronomical Society of the Pacific*, No. 140.

Co-Operation of La Plata and Detroit.— Professor W. J. Hussey, formerly of the Lick Observatory, and now Director of the Detroit Observatory of the University of Michigan, is at present engaged, according to a note in *Science*, in the reorganization of the scientific work of the observatory of the National University of La Plata, Argentine, whose directorship he has assumed in addition to his duties at Ann Arbor. Professor Hussey is planning co-operation in astronomical work between the two institutions.— *Publications Astronomical Society of the Pacific*, No. 140.

Popular Interest in Astronomy.—Presidential Address, Astronomical Society of the Pacific, 1912.

The man whose interest in astronomy is general only can also find much to arouse his curiosity in the ordinary phenomena of the solar system. To reach a correct understanding of the everyday occurrences is worth study. The spectacle of the changes of the seasons, the paths of the planets through the heavens, the march of the stars, together with such occasional visitors as comets, all repay investigation. The ordinary man can approach this subject as did those men of old whose first feeling of wonder insensibly led to the investigation of things seen until the science was born. He can with the ancients observe a planet, tracing its epicyclic path on the heavens and thus realize the broad mind of the Polish monk, who by substituting simplicity for complexity, explained the problem that had baffled the best minds of all time. He can, after making the acquaintance of the members of the solar family, of which we are a part, leave the restricted confines of that system and with an untrammelled imagination, penetrate into the depths of space,

conscience that however far he may roam, there will be always something beyond.

One final thought in this connection deserves comment. There has been on the part of some writers a tendency to belittle the position of man in his relation to the universe as gradually the confines of that universe were enlarged, finally to an infinite distance. The old anthropocentric conception was amazing in its effrontery, and when in the light of science it was overthrown, it apparently left man humbled into the dust. His insignificance seemed measured in the ratio to the distance to the stars. As the concept of the cosmos grew, man decreased to a vanishing point, and he may, in his unthinking moments have exclaimed, as did old Omar in his despair at not finding the hand that worked behind the veil. To this I can not subscribe. It is my contention that all the revelations of astronomy have but served to elevate and ennoble mankind. The ignorance of the ancients did not in any way elevate their position, but rather the intellect that can now behold with comprehension a storm on the sun or the slow revolution of two distant stars around their centre of gravity or the formation of worlds from the nebulous dust of the heavens is not belittled by mere physical comparison of size. In the light of reason, comparative magnitudes vanish. Thus developed, the mind of man becomes perhaps a part of that supreme intelligence of which the visible universe is but a symbol before the limited intellect of the star gazer. Viewed in this way, the researches of the astronomers have, by enlarging the intelligence, added immeasurably to the nobility and the dignity of mankind.

Observations of Jupiter's Galilean Satellites.—On April 4, 1911, a partial transit of No. III. was observed. A table gives differences between observed times and those computed by de Sitter, those in the Nautical Almanac and those given by Sampson's tables. The differences range from −0·6 to −12·5 minutes.—*Transvaal Observatory Circular*, No. 12.

J. R. C.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries.

Query

I was much interested some time ago in reading Sir Norman Lockyer's book on "The Orientation of Egyptian Temples." In that book the impression was conveyed that the enquiry was rather new at the time of the publication of his work.

Would it be possible to learn in "Notes and Queries" if any advance has been made in this enquiry.—T. H. W. (Hamilton).

Answer

Thinking Sir Norman Lockyer best qualified to answer this query the Editor wrote to him, and was pleased to receive the following reply:—

"No advance, I think. The archæologists seem to hate astronomy and so reject any aid it can give them. I have written 'Stonehenge' to show that the same astronomical considerations were employed in the construction of the British monuments, and another book 'Astronomy for Archæologists' giving instructions; but without effect, because angles have to be measured and the true north point determined, and these things they will not or can not do. (Sgd.) Norman Lockyer."

Query

Observer's Handbook received. Greatly improved. Do not understand the magnitudes on the star maps "0 to 4." What class of stars do you put under 0?—W. H. C.

Answer

It is usual to group together the twenty brightest stars in the sky and consider them to be of the *first* magnitude. But these differ very greatly amongst themselves. Thus Sirius (α Canis Majoris) and Deneb (α Cygni) are both first magnitude

stars, but the former is 13 times as bright as the latter, while the latter is only 1·7 times as bright as Castor (α Geminorum) which is a second magnitude star.

In a scientific arrangement of the stars according to brightness stars which are just visible to the naked eye are taken to be of magnitude 6·0 and those which are 100 times as bright are of magnitude 1·0. Altair (α Aquilæ) and Aldebaran (α Tauri) have this brightness and are taken as standard first magnitude stars. These are $2\frac{1}{2}$ times as bright as stars of magnitude 2·0, while a star of magnitude 2·0 is $2\frac{1}{2}$ times as bright as one of magnitude 3·0, and so on. Thus if two stars differ by exactly one magnitude the brighter is $2\frac{1}{2}$ times as bright as the fainter.

Suppose, now, a star is $2\frac{1}{2}$ times as bright as Altair. How will its magnitude be represented? Clearly by 0·0; Arcturus is such a star. A star $2\frac{1}{2}$ times as bright as Arcturus should then have magnitude − 1·0, and one $2\frac{1}{2}$ times as bright as this would have magnitude − 2·0; and so on. The magnitude of Sirius is − 1·4, while, on the same scale, our sun appears to us to be of magnitude − 26.

Distinction for Sir Joseph Pope, K.C.M.G.

The Editor wishes to extend to Sir Joseph Pope, Under Secretary of State for External Affairs, Ottawa, hearty congratulations on his being made a K.C.M.G.,

For a long time Sir Joseph Pope has been an enthusiastic amateur astronomer and a member of the Council of the R.A.S.C. In next issue will appear a paper by him, on "Astronomy as a Recreation."

Interesting Numerical Relation

Professor L. B. Stewart draws my attention to the following interesting relation between astronomical and terrestrial units of distance:

If the astronomical unit of the solar system — the earth's mean distance — be represented by 1 inch, then the light year

becomes 1 mile, very approximately, the exact number being 0·99896 mile.

The distance of a star having a parallax of 1″ is, on the same scale 3·2588 (or approximately 3¼) light years. The distance of a star in light years, or miles on the above scale, may then be found by dividing 3¼ by its parallax in seconds. Thus the distance of α Centauri is 4·345 light years.

Lunar Exhibition at Barcelona

The wonderful growth of the Astronomical Society of Barcelona has already been referred to in "Notes and Queries." At present it has over 400 members, and its officers exhibit great enterprise and enthusiasm. Recently one of the members, M. Raphael Patxot, presented to the Society his observatory and its entire equipment, which includes a double equatorial (visual and photographic) with objectives 8·4 inches in diameter, together with prominence spectroscope, micrometer, helioscope, sidereal clock, geodetic theodolite, etc. The observatory will be removed to Barcelona in order to give the members and the citizens generally more effective use of it. To meet the expenses of this a voluntary subscription was taken up and 3139 pesetas ($612) quickly raised.

The Society proposes to hold during the months of May and June a General Exhibition of Lunar Studies and of Instruments for Observation, and its energetic secretary, Mr. Salvador Raurich, writes urging that the Royal Astronmical Society of Canada be represented at the Exhibition. It will be held at the University of Barcelona, and the executive committee promise to take especial care that no exhibit shall be injured. The Spanish Government has agreed to admit all goods sent to the Exhibition free of duty. Exhibits should be addressed to Salvador Raurich, Secretary, Calle Diagonal, No. 462, 2°, Barcelona.

Drawing of the Moon

Mr. Henry Harrison, of Jersey City, N. J., a member of the R. A. S. C., an amateur astronomer and a competent artist, has

placed in the hands of Mr. J. R. Collins, Secretary of the Society, a number of copies of an excellent drawing of the moon, at the age of three days. The reproduction is in colors by lithography and is well done. The plate is 2 feet square, the image of the moon being 18 inches in diameter. Copies can be obtained, as long as they last, by application to Mr. Collins, the only condition being that the recipient shall have a frame put on the picture in order to preserve it.

Theories of Cosmogony

The address of Professor DeLury, the retiring president of the Society, printed in this number will be read with pleasure. It draws attention again to the profound problem of the origin of our system, a subject which has a great fascination for speculative minds.

In this connection reference may be made to a series of articles which have been appearing in *Knowledge*, beginning in the September, 1911, number. Their author is Professor A. W. Bickerton, and they are well written and beautifully illustrated.

Professor Bickerton's home is in Christchurch, New Zealand, the seat of Canterbury College, of the University of New Zealand. In this institution he taught chemistry and physics from 1874 to 1902. The appearance of Nova Cygni in 1877 led him to astronomical questions, and in the course of his studies he developed his theory of partial impact and the formation of the third body. With the assistance of influential friends he was recently enabled to go to England to present his theory more fully to the scientific world. He has also published a book on the subject, "The Birth of Worlds and Systems."

The object before Professor Bickerton is briefly as follows:

> To explain his theory of Partial Impact and the formation of the Third Body, and the many extraordinary properties it possesses; and to show that cosmic impact is not an accidental and destructive occurrence, but a law of nature brought about by a great number of agencies, and that it is the most powerful constructive factor in the whole scheme of creation.

Professor Bickerton's views have met with strong criticism

in some quarters, and it is not at all easy to pass a final judgment on them. Every theory of cosmogony which has been proposed has some weak points, and, indeed, there is no branch of science in which it is easier to fall into error. There are so many varying factors which must be taken into account in developing any such theory that only the most gifted and clear-sighted philosophers have been able to make much progress in this work.

The illustrious Laplace assuredly exhibited the proper mental attitude when, in presenting his famous hypothesis, he said he did so "with the distrust which should be inspired by everything that is not the result of observation or calculation." The ordinary student of science might well also have an open mind, ready to receive assistance from any hypothesis but not carried away by glittering generalities.

Publications of Pomona College

The Editor has received three numbers of the *Publications of the Astronomical Society of Pomona College*. This Society was founded April 20, 1911, and it is to be congratulated on its work. Pomona College is located in Claremont, in Southern California, and its astronomical department is in charge of an enthusiast, Professor Brackett. One of his admirers, appreciating his work, offered him an observatory on condition that it should be known as the "Frank P. Brackett Observatory of Pomona College," which accounts for it possessing the Professor's full name.

The *Publications* contain papers on modern astronomical subjects and also predictions and discussions of current phenomena. One of the most interesting articles is an account of an astronomical expedition to Algeria in the summer of 1911. This was in charge of Director C. G. Abbot, of the Smithsonian Astrophysical Observatory, and its object was to make measurements of the sun's radiation in Algeria at the same time that such measurements were being made on Mt. Wilson in California. In this way Mr. Abbot hoped to settle the question whether the sun is a variable star or not. His observations had led him to believe that it was.

The trials and tribulations which befell the expedition are worth recounting. The International Solar Union commended Mr. Abbot's proposal, and an appeal was made to Congress by the Smithsonian Institution for funds for the purpose. Two previous requests had been refused but fortune seemed to favor this one. Mr. Abbot addressed the committee in charge of the appropriations and met with encouragement. After some "jockeying" between the House and the Senate the appropriation was accepted by both, but the whole bill with many other appropriations was postponed day after day until the last day and the very hour for adjournment came. But finally, when hope had been given up, at the last moment the hands of the clock were set back and the bill was passed.

It had been proposed to establish a station in Mexico, but the rebellion there rendered this unwise. After careful consideration a location in Algeria was selected. On July 11 Mr. and Mrs. Abbot and Professor Brackett sailed from New York, taking the instruments in 32 cases as excess baggage in order to avoid any delay in shipment. On the 20th they reached Gibraltar and on the 23rd Algiers, and as soon as possible set out for the site chosen, about 75 miles south. On opening the cases several of the most delicate instruments were found broken to pieces, and further, one case, containing an indispensable instrument, was missing. After much trouble it was located by cable at Naples and in time it reached Algiers via Marseilles. But the broken instruments were at last repaired and placed in position on piers built by the members of the party themselves, and after overcoming numerous other difficulties which had appeared in the instruments themselves and also through the weather, a valuable set of observations was obtained. These will be completely worked out at Washington, and will appear in volume three of the *Annals* of the Smithsonian Institution Astrophysical Observatory.

The Old Observatory at Delhi

In many books on astronomy are illustrations of the ruins

of the observatory of Jai Singh at Delhi, India. The observatory was the first built of five, and was erected in 1710. It will be of interest to learn that during 1910 the Government of India completely restored the ruins and it is now possible to take observations of the heavenly bodies as of old. An account of this work, together with photographs of the restored buildings, is given in the *Journal of the Astronomical Society of India* for January 1912.

The Aspect of Mars in 1909

For the beautiful drawing of Mars appearing as a frontispiece to this number the readers of the JOURNAL can thank Mr. G. Parry Jenkins, formerly President of the Hamilton Centre of the Society. The original is a beautiful crayon drawing by Mr. Scriven Bolton. In making his observations he used an 18¼-inch reflector, formerly owned by the late Dr. A. A. Common. Mr. Bolton gives the following description of the planet at the time:

> During the favorable apparition of 1909, the planet Mars was scrutinized by the aid of an 18¼-inch clock-driven Calver reflector. With a magnification of 422 times, the image of the planet was found to be perfect, while the unquestioned defining capacity of the instrument, together with the minimum distance of Mars from the earth, rendered possible a very close study of the surface detail.
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> The accompanying drawing represents the aspect of the planet a month following the noteworthy opposition of September 23 in the year named. The Syrtis Major is shown towards the preceding limb, and Dawes Forked Bay near the terminator, which, when viewed in large apertures, brings forcibly to mind the globularity of the planet, by reason of its strongly shaded and diffused character. The Sinus Sabæus exhibited a heavy north contour, and it was serrated about Sigeus Portus. Issuing from the latter the canals Phison and Euphrates are represented in the drawing, and those from the Forks of Dawes Bay were found not to be difficult objects. Both the nearness of Mars and the increased instrumental power rendered many apparent surface changes. The maria, for instance, in the region of Erythræum, and to the south of Syrtis Major, was resolved into minute darker spots or condensations, especially manifested along a number of dark veins in the maria, while the more heightened portions appeared flocculent in character. Between Hellas and Syrtis Major, the aspect of the maria suggested a hilly or almost mountainous country. The system of canals was revealed precisely as in former years, and although some of these lines may constitute a subjective phenomenon, it is not unlikely that they possess an objective basis.
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C. A. C.